VALVE

the magazine of astounding sound

Hawaii 5.0 - two ways to play a RS 5" driver

mo' heavy metal

300B taste test

new Foreplay techniques

Buddhafied Afterglow - part two

some ideas for SE 845 parafeed

da' basics - determining triode plate loads

volume 6 number 4 1999

B-Glow

single ended 300B amp kit

another masterpiece from Electronic Tonalities

active loaded 5965 driver

MagneQuest TFA-204 air gapped output transformer

8 watts

$900 the pair, you just supply the 300 Bs

VALVE

the magazine of astounding sound

Editor and Publisher
Dan “Dr. Bottlehead” Schmalle
Chief Administrator
“Queen Eileen” Schmalle
Resident Smart Guy and Technical Editor
Paul “Braniac” Joppa
Graphic Design
Bruce “Badd Dawg” Borley
Resident Hot Iron and Dr. B’s Bodyguard
John “Smoothplate” Tucker
Big gun OEM advisor
Michael “Airgap” LaFevre
The Guy With Answers
John “Buddha” Camille
Contributing Editors
David “Full Track” Dintenfass
“Crazy Eric” Lenius

Our mailing address:
VALVE
P.O. Box 2786
Poulsbo, WA 98370
by phone: 360-697-1936
business hours: 9-5 PST, Mon -Fri
fax: 360-697-3348
e-mail - bottlehead@bottlehead.com
website - http://www.bottlehead.com

editor's thing

Yo, bottleheads,

This issue I’d like to present Brad Brooks as our guest editor. Brad has been a local VALVE member this past year, and has really impressed us with his enthusiasm and commitment to the hobby. Below is Brad’s response to an inquiry by a newbie about learning the fine art of design, as posted to the Bottlehead Forum-

Don’t let the blue smoke out,

D o c B.

The following was posted by Scott Wobecke to the Bottlehead Forum:

> *How long does it usually take a bonehead in math/construction skills to build tube amps? I have a lot of ambition...Which books do you recommend reading, I’ve come across some recommendations at the Audio Asylum. I figured if there is anyone to ask its the master of DIY tube gear. Thanks Doc.*

To which Brad replies:
Here is my two cents. I agree with Quest that you should jump in and build something. Here is what I recommend, and please keep in mind that I do not consider myself a designer. I would like to think that someday I would be able to sit down with an idea, and find the right solution based on the combination of other people’s experience, my own experience, and research and experimentation.
Here are some things that I have done to help me along this path.
1. Read, Read, Read—all you can about all aspects of stereo, not just tube, design. Decide for yourself what is funk, and what is bunk. Understand that alot of what is written out there is designed to sell products. Decide what your dream system consists of, and prepare to have your ideas blown apart. Develop enough character to deal with blows to your ego.
2. Decide what sort of music you really like, and what you really like about it. Calibrate your ear with live performances. Learn to love music again, unless you only like talk radio, and even then, learn to love the human voice.
3. Listen to as many different systems, tube and transistor, as you can.
4. Build something simple, like Electronic Tonalities kits, especially since there is enough information there to help you understand the operation of the circuit—in fact, pretty much all of the ET kits are made with the idea that you will continue to refine, redesign, and experiment. Learn by doing.
5. Listen to what other competent experimenters and designers say, and listen to how their systems sound.
6. Identify small milestones of accomplishment, experimentation, design. Small things, like how to determine the best operating points of a tube, or to find what design factors are affect bass performance. Experiment.
7. Continue to evaluate everything learned, experimented with, etc...throw out useless information and disproved theories.
8. Associate yourself with experimenters—people who actually like music and build the equipment that they listen to it on. Find a club of experimenters and music lovers.
9. Have fun, and ignore the bigots and jerks.
10. RCA Radiotron Designer’s Manual, 4th ed., 1950’s era Radio Amateur’s Handbooks, RCA Receiving Tube Manuals, Valve Online Magazine (Free!), Positive Feedback, Vacuum Tube Valley, Glass Audio.
Sorry for rambling on...

Brad

on the cover

Pictured this issue is the Foreplay preamp I decided to build for myself a while back, to try out some mod ideas I had.
This preamp is now doing a tour of the staff at Audio Asylum, in our opinion the best audio forum on the web. In fact we think it is so good that we have decided to be a sponsor, and we are proud to announce a new Bottlehead Forum on the Asylum, in conjunction with this sponsorship. The forum will be a more timely way to get info out and offer answers to your DIY questions. Check it out at

http://www.audioasylum.com/forums/bottlehead/bbs.html

new xrcd2 classics from

First Impression Music

FIM XRCD 022, The Artistry of Linda Rosenthal

Linda Rosenthal, violin, Lisa Bergman, piano

A collection of timeless violin solo favorites, by the most talented student of Jascha Heifetz with dazzling skill, dynamics and colors. You have to listen to believe. A must for demo.

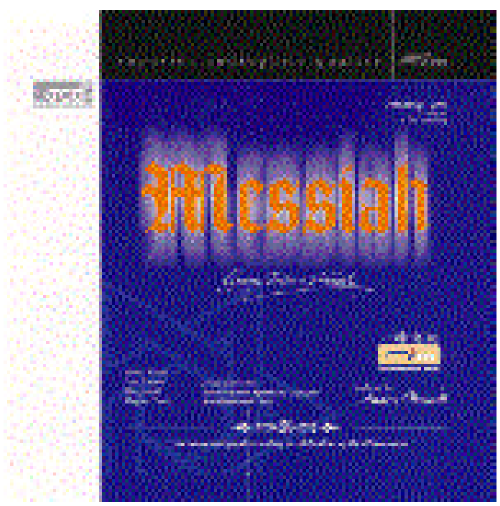
FIM XRCD 2000, Messiah *by George Frideric Handel*

Yvonne Kenny, Paul Esswood, Martin Hill, Magnus Linden

Members of the SWEDISH RADIO SYMPHONY ORCHESTRA

THE STOCKHOLM BACH CHOIR ANDERS OHRWALL. Conductor

Recorded live at the Adolf Fredriks Church in Stockholm, Sweden, on February 13 & 14, 1982



First Impression Music

#189 16149 Redmond Way
Redmond, WA 98052

http://www.fimpression.com

Tel: 425-868-5326
Fax: 425-836-9061

Hawaii 5.0

by Gregory Hee and Jason Takamori

The Weems' Project

In the mid-90's, Hiroshi Ito began showing me literature describing triode amps, horns, and speakers claiming to play "music". I was curious, but unwilling to plunk down $$$ for something I never heard.

At the library I discovered a speaker building book by David Weems. No cutting edge stuff, but something caught my eye. Weems described a single driver project using a RadioShack No. 40-1354A 5 1/4" full range driver that "gets the midrange right". Actually that's all he said.

Cheap enough. I picked up a pair to check out Mr. Weems' hearing. I sized the box to my liking and built particle board enclosures from discarded shelving. He was right! With no crossover, dynamics weren't restrained; no phase shifts, just music. Without hesitation, I built some real 3/4" MDF boxes. I surface mounted the drivers and applied a 1/8" cork sheet to the front. Kimber 8TC was used for internal wiring. Hardware was all stainless. The insides were lined with carpet pad on all surfaces. I would guess the response to be 60 to 15,000 hz. Perfect for my small room. Deep bass? Forget it, but then the highs are limited too. The sound is balanced.

For 3 years, I listened in blissful secrecy.

Enter Jason Takamori

Then at a Jazz and Audio Society meeting, Jason showed up. He asked me what I had, but I talked about coherency and emotion instead. Soon afterwards, I invited Jason and Hiroshi over. It was the first time I let anyone hear my secret system. At one point Jason looked at his watch; it was past 1:00 in the morning. He kept saying, "It grabs you". And this is through my B&K ST140.

Jason asked me what else did I have going. Well, after my experience I purchased a pair of full-range Diatones that have been waiting for cabinets, but no further experiments with the RadioShack. They weren't perfect, but aside from an Edgar tractrix horn TAD system with straight mid-bass horns, I hadn't heard anything else that made me really want it.

Jason's Super Boxes

RadioShack provided the motivation; the drivers went on sale for a mere $10 each. It was decided that the box needed to be more rigid and the drivers braced. Bracing was easy; a T-nut and a bolt with a wood plug through the rear of the cabinet sufficed. As for the box, Jason had other ideas,

like 3/4" Corian. Yes, cast cultured marble would be more rigid, but he exercised restraint. His other deviation was to follow Weems' design exactly. So how did it sound? "I can't believe it's . . .a RadioShack." Music was clearer and dynamics were more powerful. Some of the upper midrange edge present in the MDF versions were gone. Jason's Spicas went into his daughter's bedroom.

A few days later, Jason brought over a Corian version of my box (see picture and plans). They sounded wonderful too. The major difference is the larger soundstage projected by Weems' large front baffle. My speaker presents a deeper front to back perspective. It is personal choice. By the way, the enclosures are heavy!

Due to his 24'L X 16'W X 8'H room, Jason augmented his Corian speakers with two bandpass subs that Dan Schmalle designed for his Whamodyne project, powered by a Phase Linear 400. Upper frequency output from the subs is somewhat controlled by adjusting cabinet stuffing.

The ShackAttack!

Can a cheap speaker get better? Hiroshi calls it the ShackAttack.

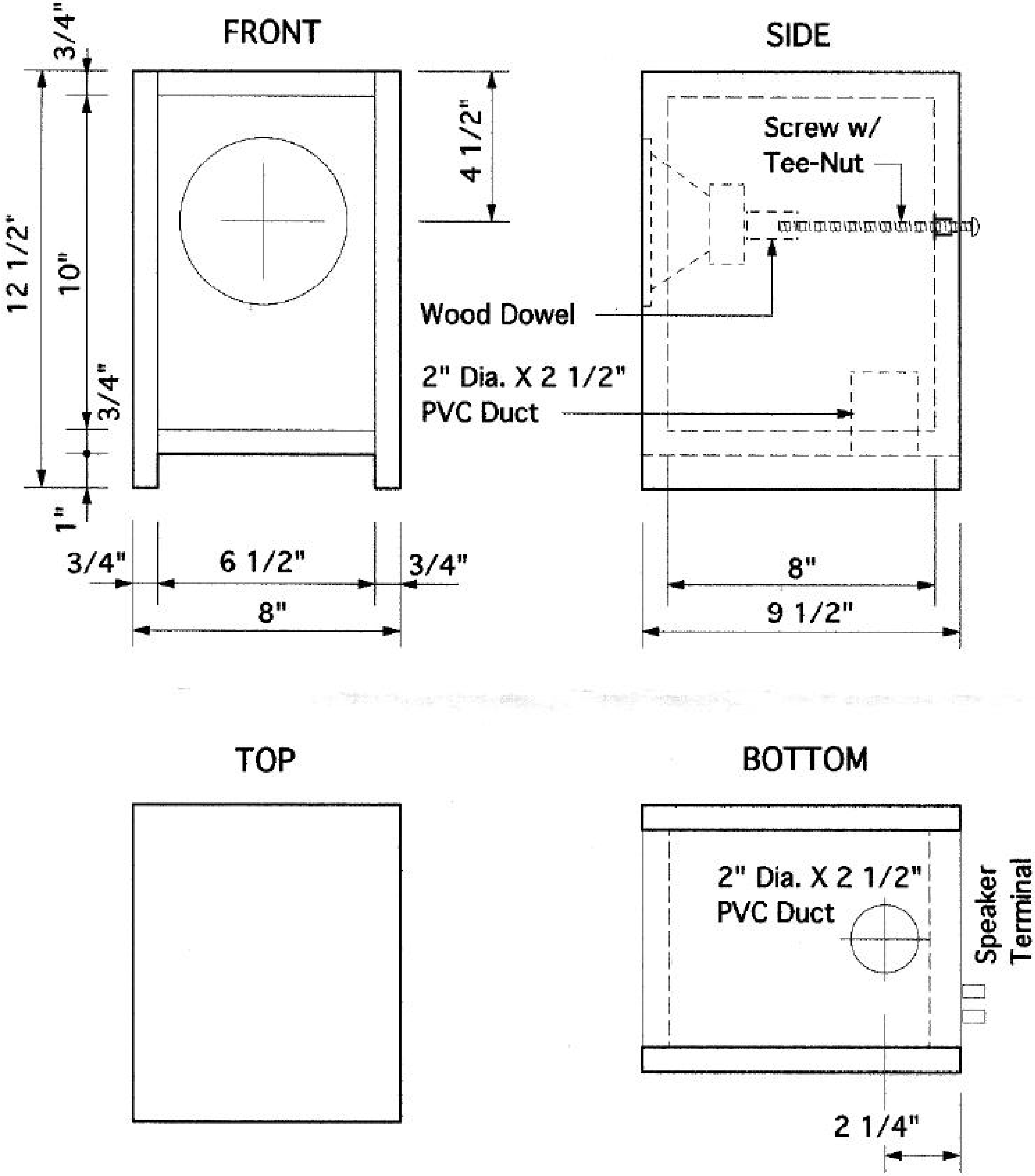
It started with 300 hz tractrix horns intended for Dynaudio D54 drivers. For fun, we put a pair of RadioShacks inside. The sound was awful. Removing the cabinet back was a transformation. The sound was effortless, smooth and big, but midrange detail was washed out. Adding a peizo tweeter to provide some "air" didn't help, but the potential was there. So with the aid of Speaker Builder magazine and the internet, Jason and I charged forwarded.

Following Dr, Edgar's construction suggestions in Speaker Builder, Jason built a new 300 hz horn (no back enclosure). We couldn't believe it. The midrange presence was back even though highs were rolled off as expected. Stereo images were deep and solid even 30+ degrees off axis. The horn mouth was still 14" X 11", but the throat was enlarged to 3 5/8" square. The drivers were mounted with a 1/4" gap from the throat. According to literature, this acts as a filter and will differ with another driver.

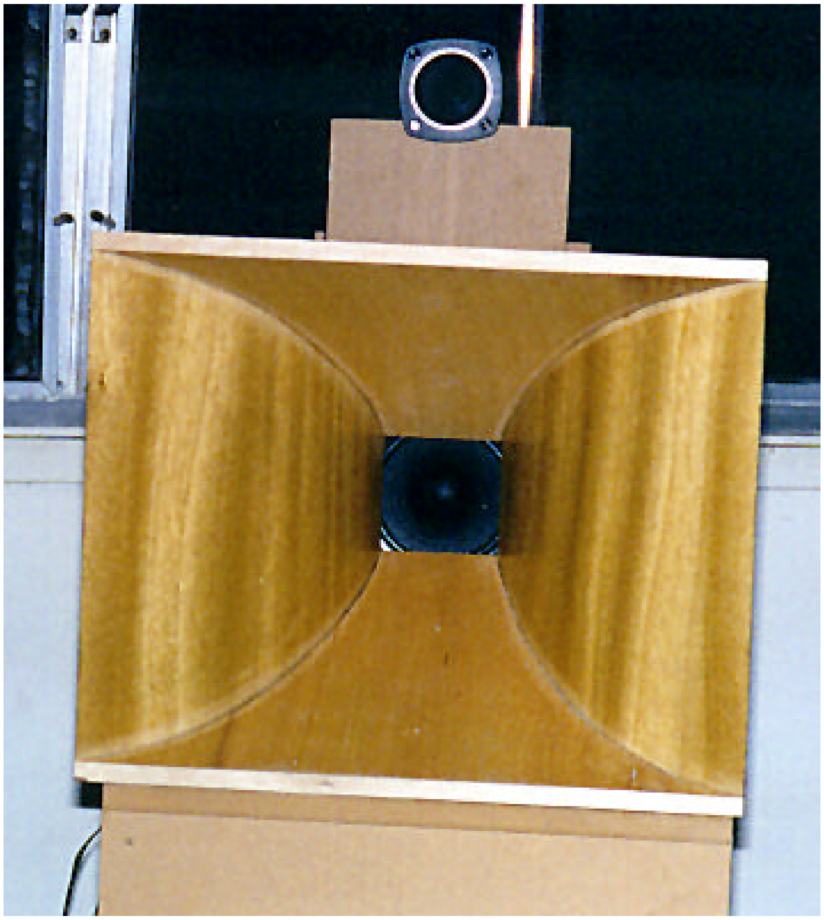
Despite success, there was a hole between the lower midrange and sub, and images were a bit small. Thus our final iteration, a 240 hz horn to extend the coverage lower. We also modified the throat mounting board. The horns do what was intended and present a realistic soundstage even when sitting only 10 feet back. (See photos)

Where Are We Now

We still listen to the Corian projects. Be-



FRONT
3/4"
12 1/2"
10"
3/4"
1"
4 1/2"
3/4"
6 1/2"
3/4"
8"
SIDE
Screw w/
Tee-Nut
Wood Dowel
2" Dia. X 2 1/2"
PVC Duct
8"
9 1/2"
TOP
BOTTOM
2" Dia. X 2 1/2"
PVC Duct
Speaker
Terminal
2 1/4"



ing a Lowther PM5A front loaded 140 hz round horn setup in Jason's system, we needed to test the line between practical and extreme. It shows promise with lower distortion and more top end.

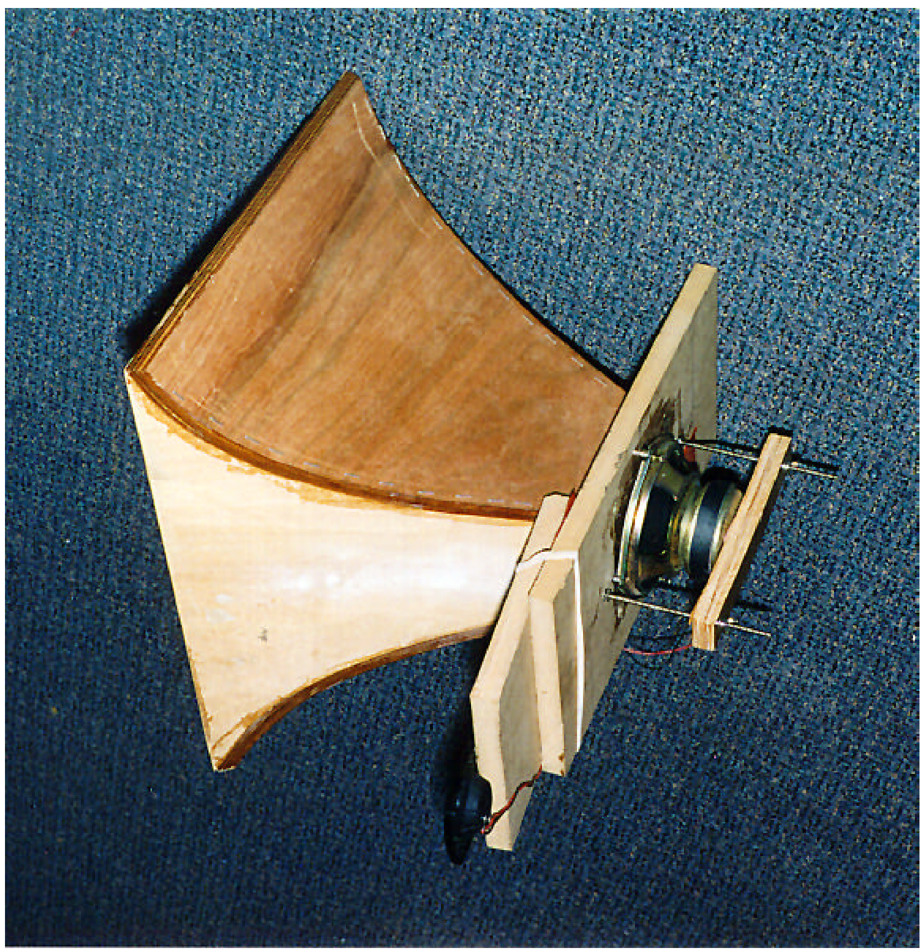
Here and Back
The RadioShacks turned out to be the key that allowed us to learn what the "to lust for" drivers do without breaking the bank. For a list price of $16.99 each, it is a bargain basement over achiever, in whatever project configuration you choose.

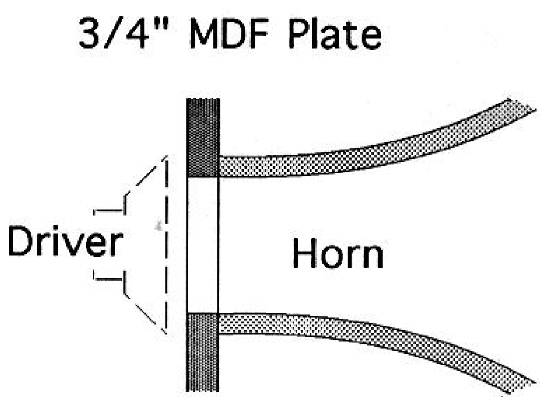
Beginners take heart. Enough information is out there so that even a pair of novices can get started. Don't blindly believe claimed efficiency. Crossovers can suck power. The 89 db rated RadioShacks in a box take less to drive than some 94+db speakers with crossovers. Build the box more rigid than you think necessary. You will hear it. Brace the drivers. Even the horn drivers were braced. Lastly, go for it. Aloha!

sides working in smaller spaces, they "grab you" in a different way. Like the horns, they convey emotion. The horns by contrast are smoother and more effortless. The horns also spurred our quest for a better sub. Remember Schmalle's beast is an under $100 project that needs no excuses. And the search is on for cheap drivers with lower distortion and a better high end.

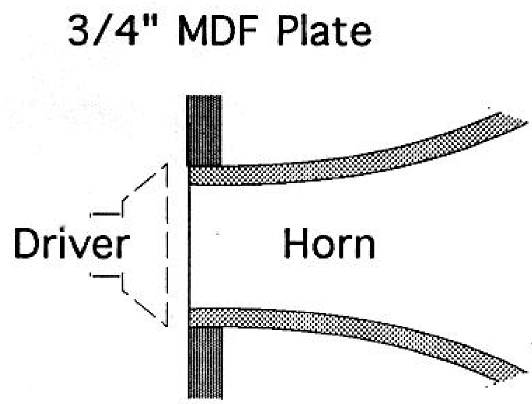
A 40 hz bass horn, driver by a JBL D140 coupled to a 6L6 bass amp now shares low end honors with the bandpass..

Are there any cheap drivers better than the RadioShack? We tried the 5" MCM driver used in the Whamodyne project. It is a good driver, but doesn't work in horn application. We also tried kevlar, coated paper and poly drivers under $60. The performance of the kevlar driver was frequency dependent and never cohesive. The horn just magnified the plastic sound of the coated and poly drivers. Voices and instruments lacked the quality of being real. It appears that paper drivers rule.
We also insertd the $300/pair Diatones which breaks the cheap rule, but after hear-



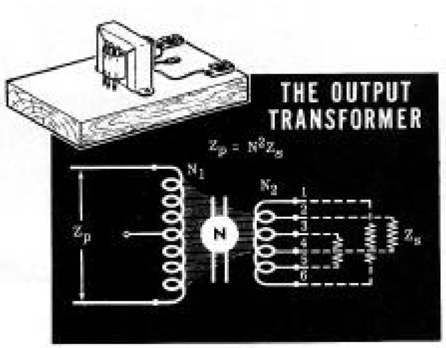


Throat adaptor as shown in SPEAKER BUILDER



Modified throat adaptor, keeps the horn flare and doesn't introduce a change in material.

Brainiac's



Heavy Metal

...an occasional review of some nifty chunk of iron (usually cheap!)

by Paul Joppa

Today's Topic:
the Allied 6K3VG power transformer

This low-cost leader (only $22.95) is one of several in the Allied catalog. All are cheaper than their Hammond counterparts, but this one seems to be the best bargain of the bunch. It looks about right for hefty preamps or small (2-watt) power amps. It weighs 2# 7oz on my kitchen scale, and the lamination stack is 3" x 2.5" x 1.06". The laminations are thick, about 0.025", but they are interleaved one by one. It is mounted vertically with metal end bells, and takes mounting holes 2" x 1.75". All the wires come out on one side.

The primary is rated at 117 volts and measures 11 ohms DC. There are three secondaries. The ratings and my measurements are as follows:

* the high voltage winding was estimated on the basis of 40mA RMS through the whole secondary, which is a reasonable approximation for capacitor-input circuits but is not exact. Leakage inductance was not evaluated but may reduce the B+ output voltage slightly.

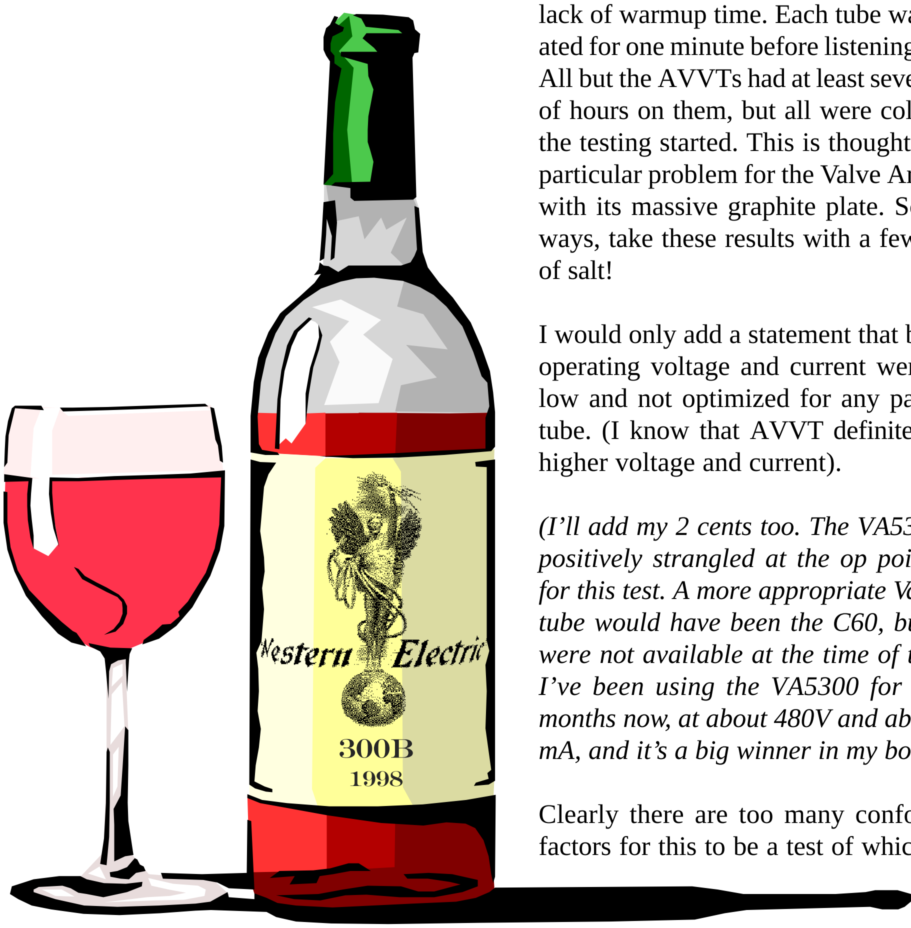
Equivalent source resistance in the B+ is about 600 ohms, or about 6% of the likely load resistance. With a capacitor-input filter and using silicon diodes, a maximum of 435 volts can be generated at 40mA. Remember however to allow for the voltage drop in the DC resistance of any filter choke used, plus the loss in the rectifier tube if used. With a choke-input filter an output of 300 volts at 60mA could probably be obtained without excess heating, again minus the losses in chokes and rectifiers.

As is typical of smaller power transformers, the regulation is not the best, so be sure to add series resistance to the filaments if you don't use the full rated current. You can probably draw more B+ current if the filament windings are not fully utilized, but no more than half the extra volt-amp capability can be used this way without excess heating.

Rated voltage	Rated current	Open circuit voltage	DC resistance	Estimated voltage at rated current
5v	2A	5,81v	0.224 ohms	5.13v
6.3vCT	2A	7.35	0.305 ohms	6.45v
325-0-325v	40mADC	367-0-367v	500 + 468 ohms	333-0-333v*

300B tube tasting

By Paul Joppa



At VSAC 98, one of the seminar events was a listening comparison of six different 300B tubes. This event came together almost by accident, starting with the realization that there were two or three types available in the local club. By simply calling around, several others were obtained - everyone was very helpful, and it is to the credit of this hobby that there is so much good will and enthusiasm on the part of everyone involved.

The setup was a good ordinary system, except for the Exemplar speakers which were definitely a couple ranks better than the rest. A decent CD player was followed by a 5670-powered preamp. The power amp was the 300B-modified S.E.X. amp, running the tubes at 325v and 55mA through a TFA-204 output transformer; the driver was a 6SN7 mu-follower coupled with a Hovland capacitor. Music was one jazz cut, followed by some symphonic Mozart - about one minute of each was played. Tubes were listened to blind the first time, then the whole was repeated after the tubes were identified. About 40 people were in the high-ceilinged room, of whom some 23 left copies of their notes.

One major limitation of this test was the lack of warmup time. Each tube was operated for one minute before listening began. All but the AVVTs had at least several tens of hours on them, but all were cold when the testing started. This is thought to be a particular problem for the Valve Arts 5300 with its massive graphite plate. So as always, take these results with a few grains of salt!

I would only add a statement that both the operating voltage and current were quite low and not optimized for any particular tube. (I know that AVVT definitely likes higher voltage and current).

(I'll add my 2 cents too. The VA5300 was positively strangled at the op point used for this test. A more appropriate Valve Art tube would have been the C60, but these were not available at the time of the test. I've been using the VA5300 for several months now, at about 480V and about 160 mA, and it's a big winner in my book - B.)

Clearly there are too many confounding factors for this to be a test of which is the "best" tube. But it did offer the opportunity to discover what kinds of differences were heard. As can be seen in the results, the range of perceptions was quite wide - in fact, one conclusion is that each person hears different things, and weighs what they hear differently, so that every tube sounded best to someone. But there is also some family character to each tube that seems to come out.

The tubes tested were the following:

- **Sovtek 300B**, purchased from New Sensor by the author for the original version of the amplifier.
- **Western Electric 300B**, a matched pair loaned by Charles G. Whitener of Westrex Corporation
- **KR Enterprise VV300B**, loaned by Ron Welborne who was exhibiting at the show
- **AVVT AV302SL**, loaned by Tony Bombera, the North American dealer for AVVT
- **Svetlana 300B**, loaned by Eric Barbour of Svetlana
- **Valve Art VA5300**, loaned by Ed Fallon

Part One - listening impressions

I made several attempts to organize the listening comments, sorting them into groups by various criteria of similarity. None of them seemed to really help, and I continually worried that this approach was filtering other people's perceptions through my own unconscious prejudices. Finally I gave up on interpreting the results. In the table below each row contains one listener's comments. The only editing is that I've removed specific relative ranking comments. All comments on the sound itself are reproduced pretty much as they were written.

Sovtek 300B	Westrex 300B	KR Enterprise VV300B	AVVT AV302SL	Svetlana 300B	Valve Arts 5300
Natural, easy, pleasant	Air; more HF	Nice air, natural decay of piano, full overall sound, bass a little recessed	Less air, nice mids, bass OK	Nice air, mids natural, tight tuneful bass larger overall sound	Soft overall, less air, mid OK, bass is fat not tight
Open, detailed, but slightly veiled	Soft, pleasant	Very nice, dynamic	Good detail & dynamics, natural tonal balance, best of six	Lush, dynamic	Pleasant but light weight
Veiled, lacks sparkle, soft; bandwidth limited, listenable though.	Quiet, articulate, nice	Midrange good, bland overall sound	Extended, clean, forceful, dynamic	Nice overall balance, highs tinny on occasion, lacks articulation	Dulled transients but nice. Spitty.
OK, not much top	More bass, same top	Recessed but more natural, more depth, more open	Dull but mids and drum good. Cymbals flat but pleasant.	Bass less but good. Treble OK	I like, good, natural. Can feel a little bass.
OK, nice piano & guitar, limited bass, sibilant treble, lack of air. Nice violins.	Again nice piano & guitar - better bass. Quite tight (faster) - better treble & good air	Drier piano, good guitar, treble not as good as #2 and slightly less air	Limited bass; piano & guitar OK. - sibilant treble, not much air	Good piano & guitar, bass not quite there - treble OK - good air.	Piano OK - limited bass again - boomy piano, sibilant, OK air.
Fairly good.	Very good	OK	OK	Very good	Slightly brighter
Nice, mellow, smooth, laid back.	Fuller on piano, more detailed, faster	Piano not as good as 2; good and fast though on instrumental	Good piano, more sustain. Great pace on drum. I liked this one.	Piano murkier, more spurious sounding on instrumental	Piano murky, OK instrumental, some lower mid peakiness
Nasty sibilance, fuzzy, boomy	Open, natural, some brightness at very top	A little less airy and natural but excellent dark dynamics	decent	less	boomy bass
Clear, smooth, balanced, not overly warm	Warm, rich, clear	Cool, not as engaging, but sounded accurate	Cooler, OK	Very nice tone; balanced	Appealing, balanced
Involving midrange, lacking in bass punch, highs seem a little thin	Soft or slightly veiled mid, background could be quieter. Voices clear, brass grainy	Clear highs, good detail but want more bass. Detailed voice, resolved violin	Nice midrange, reserved top end. Voices could be more resolved.	Balanced, good definition, quiet background. Nice vocal separation & violins.	Not as involving. Could be more well defined.
Nice sound	Good low end. Nice flow to the music	Soft bottom, good clarity	Good balance top-bottom	More up front & vivid that others	---
Thin, not full sounding	Some bass punch	Somewhat forward midrange	Overall average	Very quick & detailed	Muddy sounding
Nice dynamics, clear and lively. Somewhat blunt;	Warm & rich sound, slightly less dynamic	Warm but mushy. Resentful sounding	Sweet full-bodied sound. Good dynamics	Beautiful clear rich, good dynamic, human and	Hollow & dry, mechanical. Good dynamic, no soul to it

Sovtek 300B	Westrex 300B	KR Enterprise VV300B	AVVT AV302SL	Svetlana 300B	Valve Arts 5300
Nice sound	Good low end. Nice flow to the music	Soft bottom, good clarity	Good balance top-bottom	More up front & vivid that others	---
Thin, not full sounding	Some bass punch	Somewhat forward midrange	Overall average	Very quick & detailed	Muddy sounding
Nice dynamics, clear and lively. Somewhat blunt; aggressive	Warm & rich sound, slightly less dynamic	Warm but mushy. Resentful sounding overall.	Sweet full-bodied sound. Good dynamics	Beautiful clear rich, good dynamic, human and soulful	Hollow & dry, mechanical. Good dynamic, no soul to it
Blunt attack	Better balance, good dynamics	slightly smeary	Bright but not harsh. Good dynamics.	Very open.	Good dynamics, tilt towards upper mids
OK, congested	Slightly warmer; great clarity. Mids more involving. Good dynamics, impact & punch; open	Beautiful tone & clarity cooler & more neutral	A little recessed and fuzzy. A very good tube.	Soundstage more forward yet polite, vanilla. Compressed, uninvolving, veiled.	Good -?-
Very clean, natural inner detail	Thinner, less clean, less detail	Thinner still. Smaller soundstage, glary	Relaxed, quiet mellow, rounded transients, good pace	Forward, good timbre, a little upper freq emphasis	White, bleached. Less dynamic. Good soundstage, less detail.
Nice and clear - good discernible detail - low & high better high	About the same, a little more midrange	Very nice; a little more presence	Nice - maybe not as good	Very full sounding, clearer, more detail	Pretty good, fuzzier
Full bodied, forward a little, good bass and clarity	Good sense of depth, mellow, lighter bass but clean	Thinner and less depth, lighter and airy, boring	Good balance and clarity. Moderate bass and sweet highs	Nice space and air. Clear sweet highs and snappy dynamics	Easy to listen to. Clean highs but lighter bodied piano sound. Lighter bass, fine balance
No upper harmonics, no extended bass. Nice midrange.	More lower bass but a little loose, more extended highs. Nice midrange.	Real good luscious sound. Slight upper midrange suckout.	Good detail, bass a tad light	Very good dynamic, good detail	Very good, images well
Bright	Smooth. Mellow, more depth	Less defined	Balanced	Depth, weight, definition	Balanced
Lush, warm, lacks bass, mushy, soft, voices not clear	Crisp, detailed, cold, shallow. Dynamic, voices layered, good on symphony	Lush, warm, musical. Dynamic, voices clear, bass OK	Sharp, harsh, voices unclear, bass mushy	Nice, bass good, musical. Voices not clear, not detailed on symphony.	Sharp, harch, marginal bass, OK
A little thin in mids. Good frequency range, fair bass.	Lots of detail, a little thin, crisp, good tight bass control, very nice	Good bass, good midrange, dynamic	OK, not as dynamic	Full bass, dynamic, smooth, good frequency range	Different, good sound but some weird harshness, a little lacking in

Sovtek 300B	Westrex 300B	KR Enterprise VV300B	AVVT AV302SL	Svetlana 300B	Valve Arts 5300
Unremarkable, lacking detail	Detailed, rich, nice high end	Slightly edgy high end but detailed mids	Nice air but slightly edgy high end	Clear, good highs and natural sound	Slightly edgy but otherwise good

300B tube tasting , Part Two - Tests on 300Bs

After VSAC 98, I had six different brands of 300Bs on hand. I had to return two of them at the show, but four remained, and I couldn't see returning them without making at least a few measurements to back up the listening tests. This article is the result.

I had recently developed a test method which would allow me to find the plate resistance, gain, and the nonlinearity factor which I derived recently (see VALVE v.5 n.3-5). The method involves a simple experiment and a messy calculation. The experiment consists of powering up the tube in fixed bias with a plate resistor of about the normal load value, 2000-2500 ohms for 300Bs. Grid bias is varied from zero to cutoff, and the plate voltage and current are measured. The circuit is in Figure 1. Six or seven data points are more than enough.

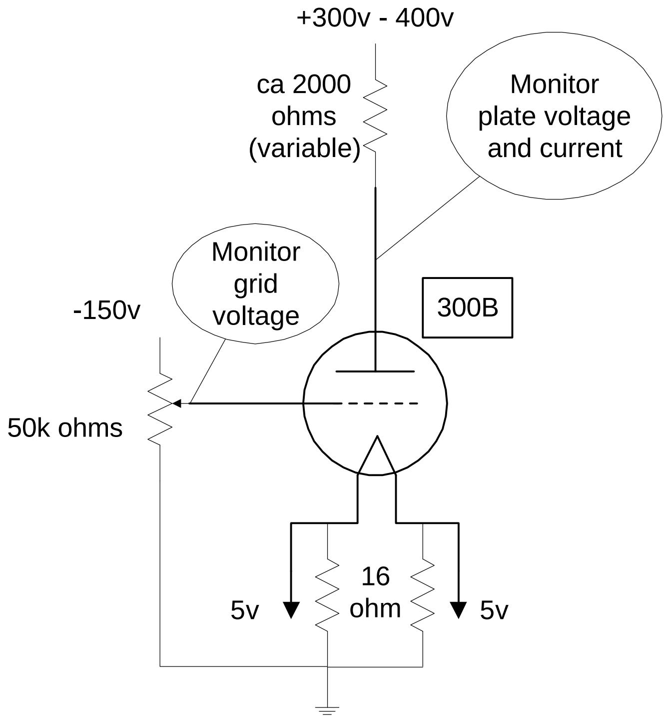


Fig. 1 - test setup.

The calculation is a nonlinear least-squares fit of the data to my model of tube nonlinearity, in which current I is the integral of the 3/2 power law over a Gaussian distribution of gain:

$$I(Eb,Ec,\sigma) = \int_{1-3\sigma}^{1+3\sigma} \frac{\exp\left[\left[-\frac{(\mu-1)^2}{2\cdot\sigma^2}\right]\right]}{2.5\cdot\sigma}\cdot(Eb+\mu\cdot Ec)^{1.5}\,d\mu$$

Eb is plate voltage, Ec is grid voltage normalized to a m of 1, and s is the standard deviation divided by the average gain. The curve fit is done on equations of the form $Ib_i = K\cdot I(Eb_i, Ec_i\cdot\mu x, NLF)$ where the variables in the curve fit are perveance K, average gain mx, and the nonlinearity factor NLF. I used MathCAD software to work out the fit. The plate resistance at a given current can be calculated from the perveance.

This table summarizes the results, for both samples of each brand:

Tube	gain m	plate resistance rp, W	NLF
Sovtek 300B	4.085	542	0.146
“	4.079	563	0.141
AVVT AV302B	3.468	981	0.102
“	3.733	862	0.105
Svetlana 300B	4.056	666	0.112
“	4.018	645	0.116
Westrex 300B	4.034	631	0.117
“	4.006	625	0.113

The AVVTs were not a matched pair, but the others were. As can be seen, matching was extremely good for all brands. Figure 2 shows a typical comparison of the measured current against the current from the model above; the fit is quite good. All tubes were run at 5.00 v rms on the filament except the AVVTs which were run at 4.80 v rms, at the suggestion of the retailer who so kindly loaned them (Tony Bombera - thanks, man!).

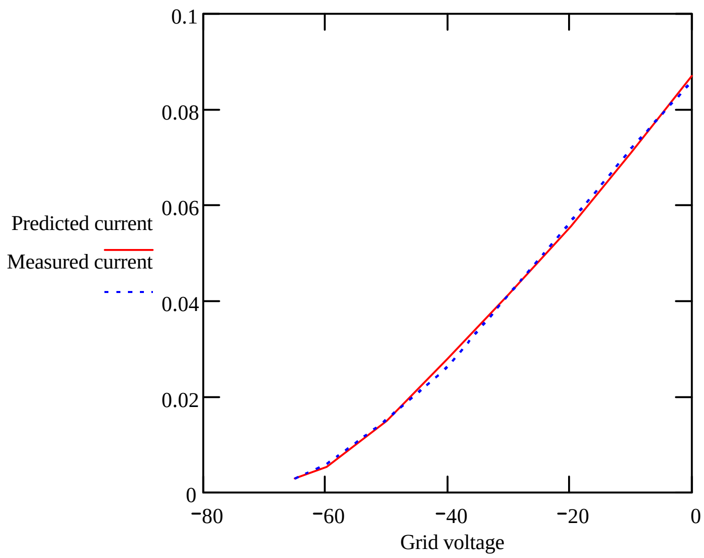


Figure 1. Predicted versus measured current

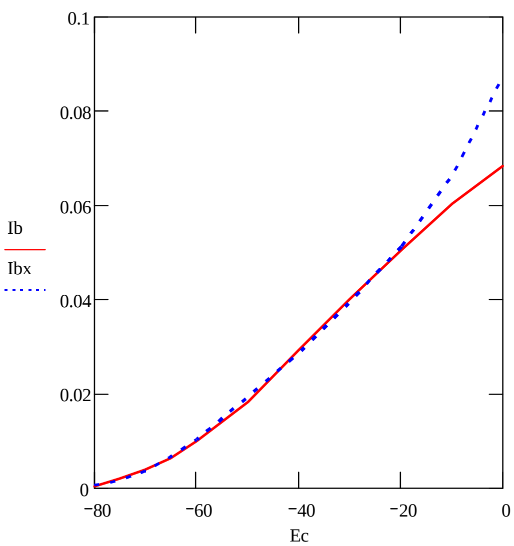
A few comments can be made on these results. For one thing, the NLFs are not as low as I had thought they would be. This might be because of the AC filament heating, however - further study might reveal more about this. The AVVT tubes meet their claim of being more linear than any other, but they pay for it by having lower gain and higher plate resistance. All are still well within the expected tolerances relative to the nominal specifications of 3.85 gain and 700 ohms plate resistance.

A few things puzzled me in the course of making these measurements. One was the high distortion of the Sovtek tubes, and the interesting results published recently in Vacuum Tube Valley where this tube was found to have better linearity if the filament voltage is lowered. So I tried running these tubes at 5, 4, and 3 volts, with these results:

Tube	gain m	plate resistance rp, W	NLF
No. 1 at 5 v rms	4.085	542	0.146
… at 4 v rms	4.104	572	0.133
… at 3 v rms	4.151	653	0.114
No. 2 at 5 v rms	4.079	563	0.141
… 4 v rms	4.127	594	0.124
… at 3 v rms	4.090	737	0.079

It looks like I have confirmed Matt Kamna’s results - they do indeed get more linear at lower filament voltages. At 3 volts, the increased plate resistance suggests that this is not really enough filament voltage - the emission is really being limited - but it looks like they’ll run happily at 4 volts. Incidentally, I also listened to them in my amplifiers with about 2.8 volts on the filament, which is what I get in the 2A3 filament switch position - they sounded a bit cleaner to me, but seemed to run out of steam on loud passages. At 3 volts, the filament glow cannot be seen even with the lights off!

The other puzzlement was that one of the AVVT tubes seemed to have limited emission. In order to get a good fit, I had to leave out the highest current test conditions. Figures 3 and 4 show the two AVVTs.



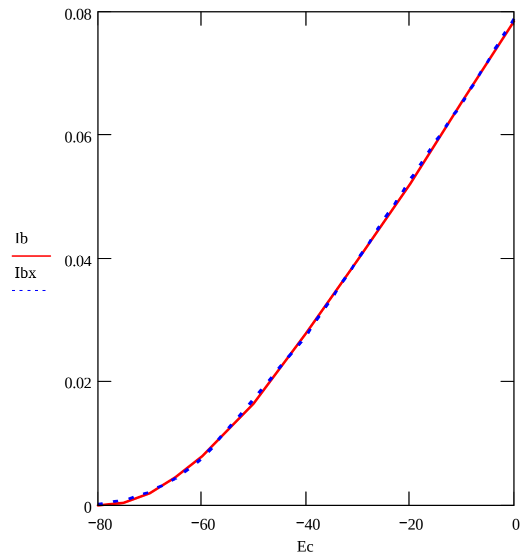


Fig 3 - weak emission, Fig. 4 - strong emission

While I was scratching my head about this, I got an email from Jim Dowdy asking if I would be willing to measure the nonlinearity of some AV300Bs that he had recently acquired. This was too good an opportunity to pass up, so I accepted gladly and he sent me ten of them for testing. The tubes were branded Audio Note, and older than the AV302SL's that were tested above. This turned out to be quite interesting!

On first testing them, I found that 8 of the 10 tubes seemed to have the same emission limit "problem." To clarify this problem, I tested a Sovtek and a Svetlana 300B (both of which had been used for 20-100 hours). They showed no drift at all, and would draw 110mA at 80-90 volts with zero bias. When set to draw 150mA, reducing the filament voltage from 4.95 to 4.50 reduced the current to 145mA in both cases. Using the worst of the AVVTs, I found saturation at around 100mA - could not get more current no matter what the plate voltage. The saturation current varied with filament voltage, as follows:

Vfil	Isat
4.90	115mA
4.80	105
4.70	93
4.60	84
4.50	75

This confirmed that the problem was saturation. The current is proportional to the filament voltage to the 5th power, very closely. By now, I was getting worried - was there something wrong with these otherwise beautifully made tubes?

Talking to Jim some more, however, he mentioned that he has seen these tubes drift a bit in current for the first 24 hours. So I burned two of them in, running a steady current of 70mA for a day and 150mA for another 12 hours on each. At the end of this treatment, the "problem" was completely gone! They showed no limitations at 4.80 filament volts, and could easily handle the full 200mA that my bench power supply is capable of.

The first round of testing, before the burn-in, was done with 2500 ohms in the plate lead, and 350 volts supply. This gave about 100v at about 100mA with zero bias, ant of course 350 volts and zero current at cutoff, which was usually close to -110 grid volts. I did my curve fit at -20, -40, -60, -80, -100, -110, and -120v bias, leaving out the zero bias point because it was affected by the emission problem.

Here's the results:

S/N	mu	NLF	rp
1350	3.51	.084	903
1398	3.76	.136	798
1399	3.45	.091	965
1418	3.72	.123	779
1426	3.58	.103	880
1445	3.72	.128	825
1446	3.72	.118	811
1456	3.69	.152	836
1472	3.66	.136	804
1484	3.67	.124	815

I repeated the analysis leaving out both the zero and -20v bias points, but the results seemed to virtually identical, which I took to mean that only the zero bias point was affected.

After burning in the worst two, I got these results:

S/N	mu	NLF	rp
1399	3.67	.129	851
1426	3.75	.130	776

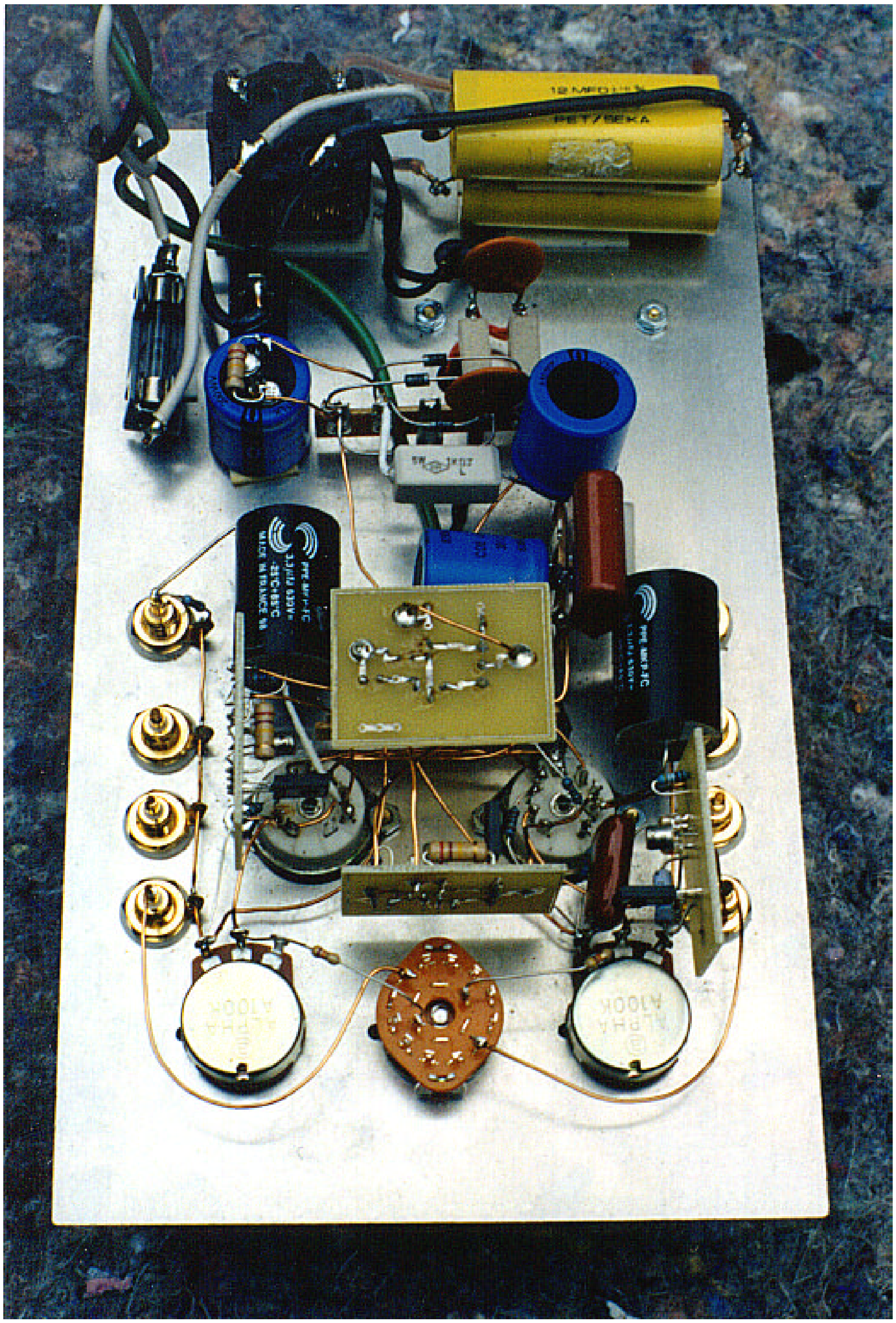
Note that all the parameters are now very close to the averages of the other AVVT tubes.

I conclude that these tubes simply need a good break-in period, at least 24-48 hours, before they will perform properly. They are tested at the factory for emission, but this is a pulse test which I suppose relies on the space charge more than the steady-state emission. The equivalent steady emission seems to be 80mA in the factory test, based on my reading of their specs.

As for the parameters, the mu is on the low side (others usually measure about 4.0) but within spec and the plate resistance is on the high side (I've measured 700 ohms or less) but again within spec. The nonlinearity factor is about the same as all the other 300Bs I've measured.

As far as I can tell, the only limitation on these tubes is their reputation (along with the similar ribbon-filament KR tubes) for fragile filaments, apparently due to the unavailability of truly high-purity nickel. (I do recall hearing somewhere that Westrex has a stash of filament nickel from several decades ago). Assuming that slow starting with a NTC thermistor and tight control of filament voltage to not exceed 5.00 volts will prolong the life, they should give fine service. Perhaps it would be wise to not turn them on and off too frequently, though. In any case, new production from AVVT uses a new filament with a core of stronger metal, which is said to eliminate the filament breakage problems.

new strokes for foreplay



by Doc B.

After a fairly long run with the Soul Sister line stage prototype I decided I really should get around to finishing one of the eXception line stages for myself. Since this will be a bit of a project, involving the dismantling of the Soul Sister, and since I had given my demo Foreplay to Mikey after nyNoise, so I decided to whip up another Foreplay in the meantime.

This would give me the opportunity to experiment with a few upgrades I had in mind.

dress sexy

Although a lot of Foreplay owners have spray painted the chassis plate, I had never tried one this way. I was really pleased with the black look of the powder coated B-Glow prototype chassis plate, so I decided to go for a black Hammerite. I did my trick of spraying on the stuff in mist coats, allowing each coat to dry before applying the next one, until I had built up a really nice pebble texture.

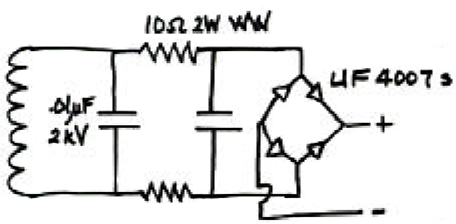
pick 'em up off the ground

Before I sprayed the chassis I enlarged the RCA jack mounting holes to accomodate the nice gold plated jacks we use with the Glow kits. The holes were made large enough to allow use of the insulators so I could get my chassis to ground buss interface down to a single point, the center terminal of the terminal strip closest to the tube sockets (terminal 13).

Most of the assembly was done in the usual manner, with the Anticipation upgrade, natch. Our super cool 20.5 ga. high purity long crystal copper magnet wire was used throughout.

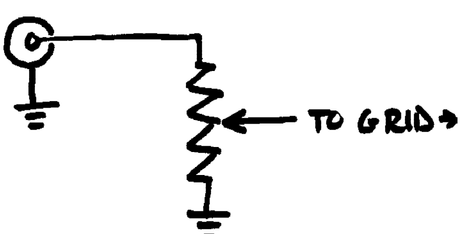
dont snub 'em, unless they deserve it.

The first deviation was the incorporation of a "snubber" ahead of the bridge rectifier. See Buddha's Afterglow article in this issue for a description of it's function in a far more coherent way than I can offer. This filter blocks the reverse recovery spike of the UF4007 rectifier diodes, keeping it from reflecting back into the power transformer high voltage secondary, and subsequently the heater winding and the ;rimary, and back into your other gear. Instead of connecting the red secondary wired directly to terminals 4 and 5, a 10 ohm 2Watt wirewound resistor was attached to each terminal, and the secondary leads were attached to the free ends of the resistors. Then a .01mfd, 2kV ceramic disc capacitor was attached, one lead to terminal 4, one lead to terminal 5, effectively shunting across the output ends of the resistors. A second .01 mfd cap was attached across the input ends of the resistors, at the red secondary leads.



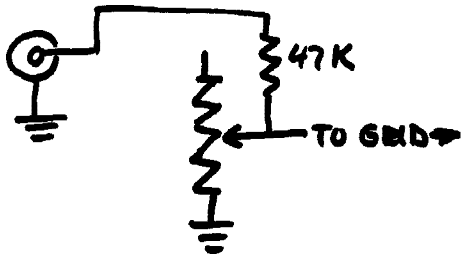
take the path of least resistance

The next trick was to convert the inexpensive 100K ohm volume pots to shunt operation. Thanks to Lynn Olson for this idea. Normally the signal from the selector switch connects to one end terminal of the pot. The other end terminal of the pot connects to ground, and the center terminal connects to the tube's grid. The signal passes thru the carbon track on its way to the wiper (center terminl) and the grid, not necessarily the highest quality resistive material.



In a shunt pot setup a 47K ohm resistor connects directly from the output of the selector switch to the grid of the tube. The end of the pot which would normally be connected to the selector is left unconnected to anything, and the other two connections stay the same.

Now the wiper (center terminal) just serves to shunt the signal to ground, but the signal does not pass through it on its way to the grid. Cool, huh.



You can retrofit this to a stock Foreplay. Just remove the wires that connect from more central pins of the selector switch to the right hand terminals of each of the pots. Now connect a 47K ohm resistor from those same selector switch pins to the terminal 2 of each tube socket. Don't mess with the other components connected to the pots.

choke them, but be careful

Between the power switch the power transformer primary I installed one simplified version of Buddha's CMC filters to cut down crap coming in on the power line. See his article once again for the latest part numbers. I use 12 mfd 250VAC caps I had on hand and one of the CMCs that Buddha sent to Smoothplate a few months back. It was a shoehorn job, but I managed to get it to fit under the chassis.

cap it off

I'm pretty careful to tell anyone who buys a Foreplay that at $99 you're not getting the best coupling caps ever made. Duh. I ended up leaving the great sounding Hovland 2 mfd caps that George Wright gave me in the preamp that I gave LaFevre. So on this one I put in the 3.3 mfd Solen caps we are now supplying with our parafeed amps. They were on hand, and ended up sounding surprisingly great for the price.

use the biggest thing you can lay your hand on

Tucker came over one day a while back and braided me a power cord out of three 6' lengths of 12 gauge solid copper wire, with a big ol' yellow Hubble plug on the end. A total pain in the ass to braid, it makes your hands ache for quite a while afterward. We put it in in place of the hospital grade cord I'd been using for my big VA5300 amp's plate supply, and the increase in bass punch had us just staring at each other goggle eyed(OK we was drinkin' beer too). Kudos to Allen Wright for the original idea, in his Cable Cookbook. Natch one of these cords made it's way onto the Foreplay.

Well, the result is a very nice preamp. I lucked out to get a set of very unique Siemens ECC82s to use, which seem to have nickel plates! They are really fast and clear compared to my favorite 5963, although a bit lighter in the bottom end. A pair of TungSol 5963s proved to make a very nice sound too, although unfortunately my pair are hummers.

To damp vibration I used one of Andy Bartha's Whatchamacallits on the chassis right behind the tubes, and a pair of IERC tube shields. This really controls any microphonics.

Had a chance to compare this preamp with the eXception at the last meeting. On Ed Fallon's system, which was a bit bass heavy and mellow on the top end, I finally managed a one time miracle and beat out the eXception, with the Siemens' ECC82s upper frequency emphasis being to the advantage. A couple hours later on Tucker's eXemplars, the eXception with a 6N1P and a nickel output transformer was the clear winner, with lower distortion when driven hard. Ditto on my own system with the Lowther front horns and an eXception using the 5965 tube.

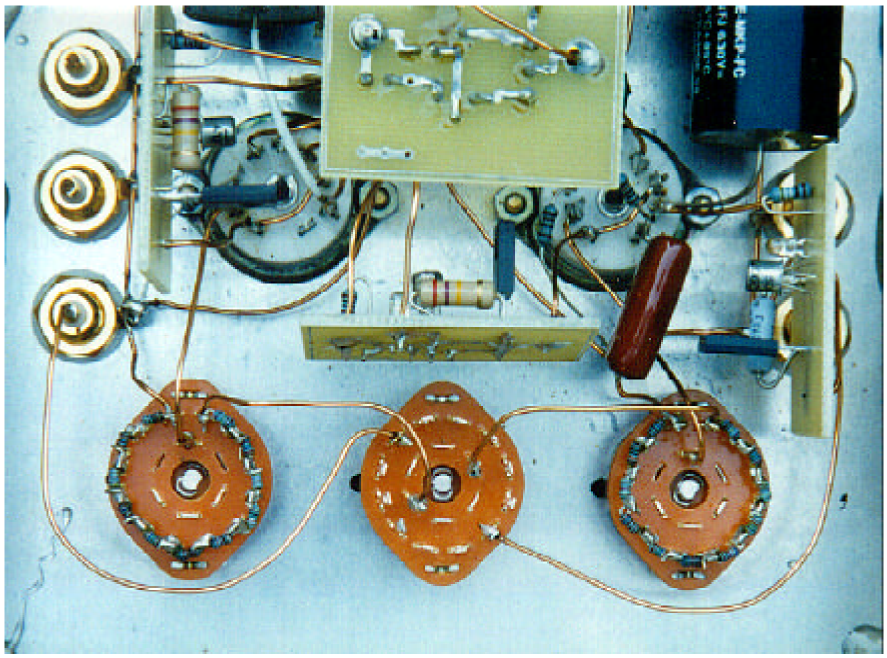
Considering the difference in cost and sophistication, I'm pretty proud that the Foreplay stood up as well as it did. Give some or all of these mods a try.

UPDATE

Since writing this article I have developed a new budget stepped attenuator. See the next page for the story

Sweet Whispers

an affordable stepped attenuator kit from Electronic Tonalities



At last, a stepped attenuator for less than $150.
We have been asked many times over the past year for an upgrade to the stock potentiometers supplied with the Foreplay preamp kit (something like ”Gee Doc, if anyone can do a stepped attenuator for almost free, it’s you”). Some Foreplay owners have also expressed a desire for a more precise way to keep the dual mono volume controls balanced. So we decided to put together an attenuator that fit with the ratio of price to performance that the Foreplay offers, no small order. We eXperimented and came up with some minor compromises that would allow us to keep the price below $50 and still offer a substantial improvement to Foreplay’s sound (yes, even over the shunt pot scheme shown in this issue).
The difference in the cost of 23 position switches and 12 position switches is confounding. The best way to keep costs down was to reduce the number of steps from the typical 23 (of which about half are never used in the typical preamp) to 12 (eleven steps plus a “mute” setting). The current switch does not have a stop at the lowest setting (something we are working on changing), but in practice this is not a big deal, you just need to stop turning when you hit the mute setting.
To keep the attenuation range flexible the step size was set at 3 dB per step instead of the usual 2 dB. This seems to be of little consequence, we don’t find ourselves wishing for “in between” settings.
In the process of determining the resistor values, we realized that we could solve a problem faced by owners of sensitive amps and speakers, that of ‘hair trigger’ volume controls that can’t be turned past about 9 o’clock before blasting. So the kit comes with two sets of resistors -a set that will give 0 to -30 dB attenuation for typical medium sensitivity setups, and also a set of resistors that will give -20 to -50dB attenuation, turning the Foreplay into essentially a unity gain preamp, similar in gain to a passive preamp. You just build the attenuators whichever way suits your system!
Along with the mono switches shown in the photo above, we managed to find a reasonably priced two gang switch. And so you can order an attenuator kit to upgrade projects that contain 100K ohm stereo pots too.
And another cool thing, they take about 20 minutes to build. You get a drawing that shows exactly where each resistor goes, and they install in a manner very similar to the stock pots. In a Foreplay you will just need to do a bit of rewiring of the ground buss once you remove the stock pots.
We said less than $150. Heck, didn’t we say less than $50? How about $40, for ether a pair of mono stepped attenuator kits, or a single stereo attenuator kit. Doc takes care of your needs, baby...

Buddhafied Afterglow - part two

by John "Buddha" Camille

Several comments and questions have been received from the field concerning the Afterglow modifications published in CyberVALVE issue3.

This modification was intended as a minimum cost enhancement to fit Ken Dangerfield's needs of the time - not a double throw down killer amp with every trick known to man or beast.

Evidently the beasts who analyze various circuit topologies with a background of audio rumor, heresay and superstition are hard at work saying it won't work.

Thus I will add a very slight embellishment to the theory of operation *(editor's note: this embellishment has come to me in the form of 34 handwritten pages - this is truly the short version where Buddha is concerned)*. I will leave it to the real experimenters to charge into the books to find out more about the whys and wherefores.

This modification did little to the basic signal circuitry - a few tweaks here and there. A dual ground was added to make the amp compatible with a follow on total system design concept for low noise (100dB SNR vs. the 50-60dB SNR of most tube equipment). A minimum of filtering and line isolation was added to the power supply. Everything in these changes was driven by the parts availability at the time and the cubic volume available. I consider the amount of filtering and line isolation now provided as a bare minimum, totally brute force and very non esoteric. Esoteric spelled any other way is m-o-n-e-y.

The power supply included a small percentage of solid state stuff to increase Ken's familiarity with the three legged fuse world. The overall circuit is also safe in that it does not require a good scope, function generator nor various analyzers to debug.

Experimenters should use the mod as a baseline, not an end all. Most parts values are not sacrosanct and in the main were determined while kitting the amp from various store shelves. Still this amp will outperform 95% of the amps out there, especially the store bought variety. Experimenters may try different techniques, parts and concepts at will - that is what valvedom is all about.

Parts Availability

Several parts listed from Tanner Electronics are no longer available. Local manufacturers and foreign travelers frequently wipe him out of the good audio stuff.

10 uF 250VAC line cap

The super small 10 uF 250VAC across line rated caps were bought out by a local fabrication shop. A near exact replacement is DigiKey pn P9408 @ 10 for $39. Tanner carries a 10 uF 220VAC tubular for $1.99. This tubular does not have the form factor of the 9408 nor is it rated for across line service, but is still legal since the primary circuit is fused. This capacitance value is also not magic, see the FL2 theory.

.01uF 6kV disc cap

The .01uF 6kV caps are no longer available at Tanner's. He has a quantity of .006uF 3kV disc caps that will work well in this application. Also see PN Reverse Recovery Filter.

K2 errata

Relay K2 was spec'd with a 9V coil vs. the actual 10V coil. Ask Tanner for the deer feeder relay.

3K32 20W 2A3 cathode resistor

This mil spec chasis mount resistor of around 3333 ohms biases the 2A3 to a little over maximum rated plate dissipation, about 15.5 Watts vs. rated 15 Watts, assuming a 425V B+. To maximize tube life increase the valus of the cathode resistor to 4K. Use Ohmite type 270/ DigiKey pn L25J4K0. This value drops the plate dissipation to around 13.5Watts. Another option is to use a 5K adjustable power resistor to set the plate current. Use Ohmite/ Memcor style AR25/Mouser 588-AR25-5K. Dont forget mounting brackets. the adjustable resistor will allow exact setting of plate curent and thus plate dissipation to your local operating conditions.

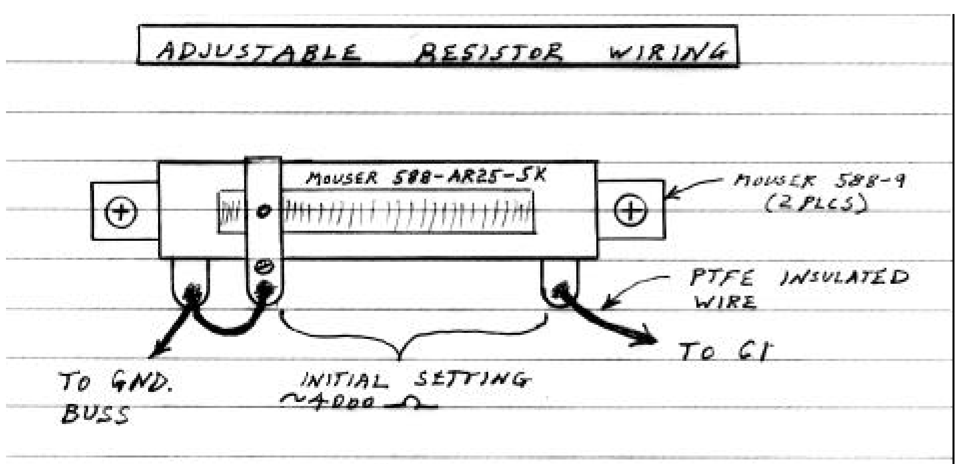
UF4007

Tanner's has had a run on his UF4007 diodes. These diodes are available at both Mouser, pn 625-UF4007. $0.25, and DigiKey, pn UF400DICT , $0.74. Am testing a new Phillips diode, BYM26E, that may be a cheap replacement.

Parts Additions/Comments

MOV addition

Somewhere along the way two protective MOVs were deleted from the power supply drawing, sheet 4. MOV1 should be added in parallel with the fourth 10 uF cap following CMC3. MOV2 should be added in parallel with the primary of T-2. Use



Panasonic pn ERZ-V20R201/Digi-Key pn P7322 ($0.72).

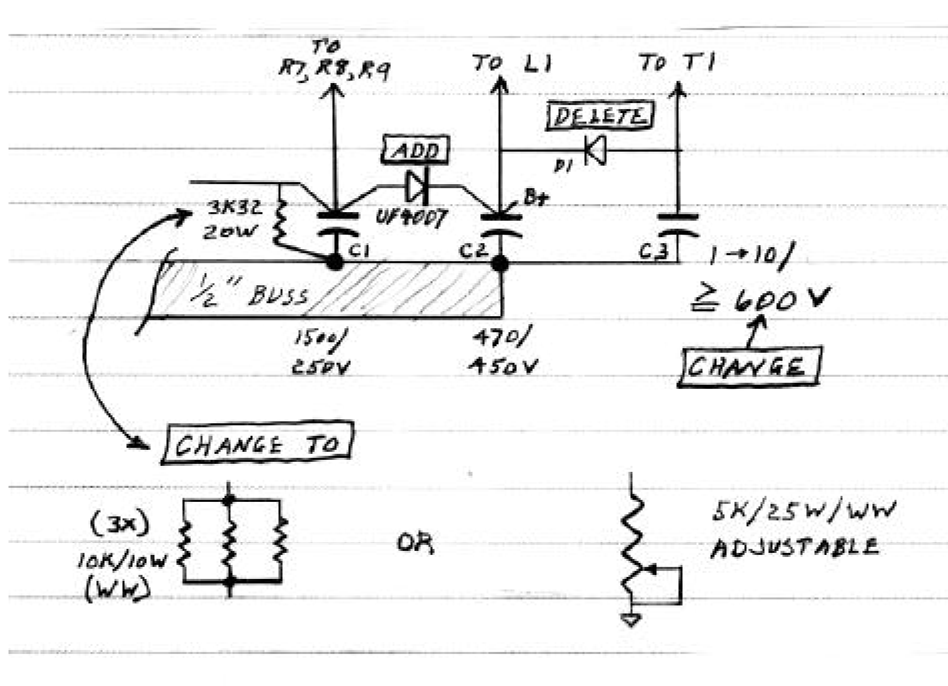
Contrary to popular belief, I add MOVs to the primary circuit after all filtering for several reasons. One, the line filter reduces the slope of the dv/dt rise from line borne impulse transients thus allowing the MOV to clip earlier in the transient cycle. Two, placing the MOVs next to each transformer permits tighter clipping of the inductive kick back of the transformer upon shut-down. This kick back transient is the usual cause of solid state failures on the down stream side of the transformer. Also, see On MOVs.

CMC change

The Panasonic common mode choke (CMC) special for CMC 1 thru 5 is spec'd at 4.7mH/4A on the crates at Tanner's. I noticed that the CMC pn ELF-18D850B is now spec'd at 3.3mH/4.2A in the latest Digi-Key catalog. The CMC will probably meet both specs but I wanted to eliminate the confusion. Tanner also has a TDK pn 472Y4R0t CMC rated at 4.7mH/4A. Both CMCs are less than a buck a piece. I prefer the TDK.

Relay K2 substitution

The specified relays out two sets of contacts have been used to switch secondarty circuits at voltages up to 400VAC above ground. However, this has only been done in conjunction with primary power switching, done here with K1. The contact point spacing may not hold off stepped up line transients if the transformer were constantly energized as in some other applications.
Circuit changes or substitution of another relay may cause problems so check it out.



Rather than dragging out my hi-pot supply, I kludge up an AC supply and let it run for several hours per contact while doing something else. This technique allows possible carbon tracks or other insulation failures to develop. Blow the relay here, not after it is installed.

Discharge Diodes

Delete the discharge diode D1 between C2 and C3. This diode was originally used to discharge C3 in order to prevent magnetization of the OPT core duriong shutdown. However it has been found that resonant effects can develop significant AC voltages with some secondary loads on the OPT. Thus diode D1 may become forward biased during part of the AF cycle causing clipping. Diode D1 is replaced by a realy circuit that will prevent OPT core magnetization from both charge and discharge currents to C3. See Demag Prevention.

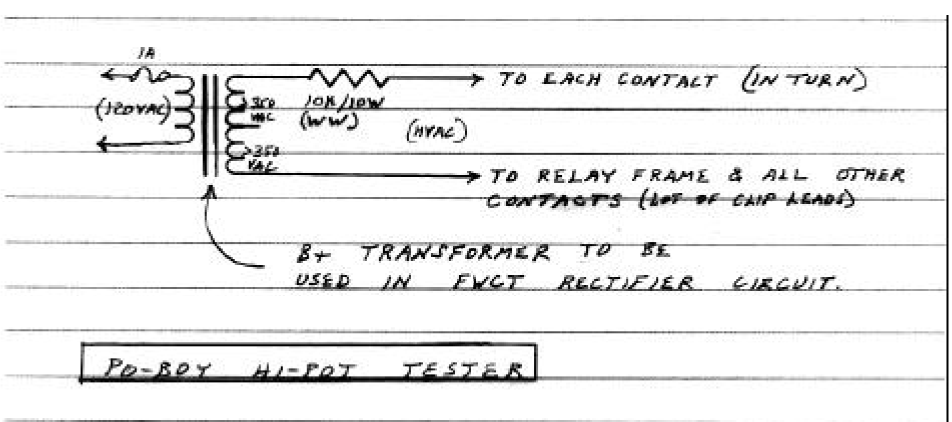
Add a UF 4007 discharge diode between C1 and C2, see the drawing. This diode speeds the discharge of C1 during shut down. I mentally miscomputed the time constant of C1 (1500uF) and the cathode resistor (3320ohms) at around 2 seconds, vs. 20 seconds (25 actual). My power of ten neuron dropped a digit. This fix will decrease cathode stripping in V1.

Bypass Cap C3

Change the voltage rating of C3 to 600-630 VDC. This change will provide a slightly better safety factor against low frequency resonance effects and the resultant high voltages that can be generated across C3. the experimenter should be aware thet the load on the secondarty of the OPT has large effects on the amount of voltage generated on the primary.

A momentary disconnect of the speaker load will cause extremely high voltages to be generated by the series resonant circuit, more than enough to break down the insulation of C3 and possibly the insulation in T1. Of course this failure mode will occur only if the load is removed when a low frequncy near resonant signal is being amplified.

It is also concievable that a speaker having



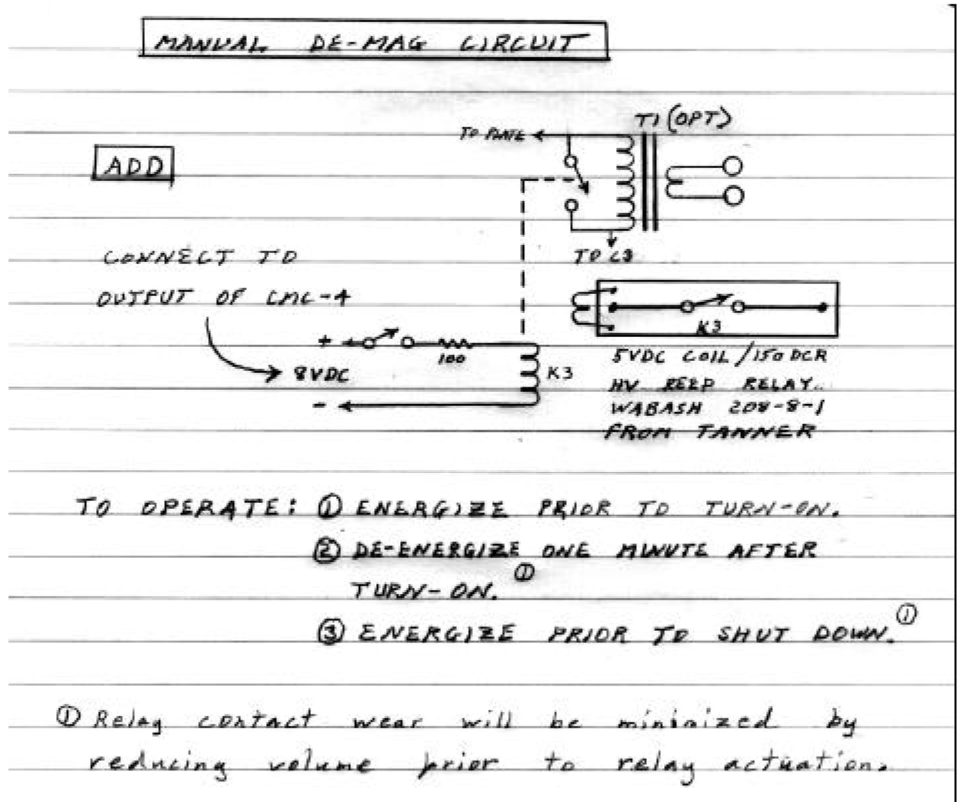
low frequency resonant Z peak in the 10 to 30Hz region may cause the same problem. It might be wise to measure the AC voltage across C3 with your normal speaker load while playing a series of low organ pedal notes or a test record, to see what happens. Fortunately for most pocket books, most SE speaker systems are resonant at much higher frequencies, mitigating this problem.

This resonance problem does not affect systems that use very large value of capacitance for C3 where series resonant effects are well below the magnetic capability of the OPT.

Manual OPT core magnetization prevention

Add a manual magnetization prevention circuit, see drawing. This circuit adds a realy and manual switch to short the primary winding of the output transformer during turn on and turn off cycles. The idea is to prevent magnetization of the OPT core by the virtually DC charge and discharge currents of C3.

I found that these DC currents caused measurable (visible on the scope) magnetic saturation effects within the nickel OPT in a tuner I was developing for bottlehead Bruce Nilson. An automatic demag circuit was developed for the tuner but it is too complicated for this basic amp. Thus the manual circuit is recommended. It will prevent core magnetization and should provide faster “warmup”. I found that it took almost an hour for the tuner’s MagneQuest B7 line transformer to “clean up” with a 20Hz signal at normal output - 1VRMS. At full output , 5.5V RMS, the transformer still required several minutes to demagnetize.



Why did you do that’s?

FL2

The network consisting of CMC 1 thru 3 and the four 10mfd capacitors serves several functions.

First, the network serves as a low pass filter that starts rolling off at several hundred Hertz. FL2 is effective to well over 50 kHz where the line filter FL1 starts becoming effective. The FL1/FL2 combination reduces line borne noise fairly effectively in a relatively small volume and is dirt cheap for the isolation provided.

Second, the network is also a rough approximation of a linear transformer that reduces the AC RF line impedance significantly. For the experimenter with CAD capability, FL2 can be optimized using modern network filter theory algorithms such that the output impedance is a sub multiple of the input impedance. AC powerline RF impedance normally runs in the 100-150 ohm neighborhood This impedance can be halved or quartered without too much trouble. the L’s and C’s can get pretty big volume wise, however. While you’re at it, put a notch at 180Hz where the worst noise side band usually exists.

Thirdly the filter FL1/FL2 smooths rectifier current impulses that travel back down the power line to low level stages in the audio system.

To be facetious, we are trying to simlulate a kilobuck line cord here. A general rule of thumb should be intuitively obvious to the most casual observer - if you can hear the effects of a line cord you need work on your power supply.

Schottky diodes for BR1

Using Schottky diodes for low voltage high current supplies virtually eliminates the noise generated by pn diodes. The often recommended high current bridges commonly called out for filament/heater supplies generate seious amounts of reverse recovery noise. These high energy noise transients are virtually impossible to filter. Since Schottky diodes have essentially no minority carriers they produce very low level diode noise spikes. these low level spikes are readily removed such as is done with CMC4.

Schottky diodes also have roughly one half the voltage drop of pn silicon diodes, thus greater headroom is usually available to down stream regulators.

RLC filters for HV rectifiers

The pn silicon diodes used to rectify the high voltage B+ power generate a significant reverse recovery spike (actually a damped wave with a very high initial pulse). The specified UF4007 diodes from Tanner’s have a pretty clean recovery spike - comparable to HEXFREDs. In fact in several installations I have found the UF4007 easier to filter than the HEXFREDs faster recovery spike.

At any rate, brute force RLC filter networks on each side of the rectifier diodes attenuate these spikes significantly - usually down to the millivolt level. The filter formed by CMC6 and companion capacitors further drop the 10-20mV spike train down into the noise.

NOTE: the filter/diode networks should be assembled using extremely short leads, RF style, preferably on a perf board with a ground plane. In this supply all HV parts from K2 thru the third 470mfd cap can be mounted on a proto board available from Tanner's. Ask for the TI puddle board. Of course the smoothing chokes L1 and L2 are chassis mounted. Twist and shield leads to the board from T1, L1 and L2. Shields should be returned to the ground plane that in turn is returned to the chassis through 3/8 inch stand off spacers. All small parts should be mounted on the solder side of the board and thus shielded between the ground plane and the chassis. Also, ground plane clearance holes should be countersunk slightly with a 1/4" metal drill (120 degree rake) where HV leads pass through the board. Deflux the board and shoot with several coats of clear Krylon for added safety. *(Dang, Boss, and this is the quick and dirty method???!! - B.)*

The L (inductance) portion of the above filters is provided by the use of 10 ohm wirewound resistors available from Tanner's. Alternatively a 1/2W carbon film or carbon composition resistor may be close wound with #34 magnet wire. This method is much less effective than the small wirewounds. Be sure the first color code stripe is double width, signifying wirewound, when purchasing.

B+ discharge circuit

B+ may be conveniently discharged very quickly (<2 seconds) by utilizing the center normally closed contacts on K2.
NOTE: observe the schematic and tie the 150 ohm resistor from the B+ buss to relay lug 2, not lug 8, which should be grounded.

The primary reason for this circuit is to rapidly discharge the HV buss in order to reduce cathode stripping as the filaments/heaters cool after shut down. Tubes are not a quarter each anymore and the total additional cost of this mod is around 25 cents.

In addition the discharge circuit will probably be exercised a hundred times during the debug and will no doubt save several skinned knuckles.

Lastly, a bleeder that draws adequate current (10%) will dissipate another 4.5W of under chassis heat (40Kohm resistor) and take 5 minutes or more to drain the HV buss to safe levels.

C4S diode

Why place the back biased diode across the C4S for V1? Probably not really required for this particular circuit but it has been found necessary in other circuits, especially RC coupled stages. <u>I recommend using the diode on all C4S installations.</u> Here's why:

The C4S has been tested and used by the author and others in various installations and has been found to be very robust. However some field installations have popped the driver transistor several times. This high Beta very small structure transistor does not like back bias currents of more than a few milliamperes. This current can be generated by several mechanisms. The most likely mechanism in this installation is arc back between the plate- grid structure of the 2A3. Arc back is self clearing and usually goes unnoticed but happens periodically, especially in new tubes. Small particles of filament/cathoe coating and other foreign particles and debris break loose and may be propelled by electric fields to a point where the arc occurs. this arc back biases the C4S and the transistors avalanche. This avalanche current is too much for the fragile high gain driver transistor.

Another failure mode occurs when the C4S is used to feed the plate of an RC coupled stage. The charged coupling cap back biases the C4S on shut down and once again the avalanche current may pop the three legged fuse.

Other failure modes are out there, including hameous fistus, but the UF4007 should be fast enough to correct the problem.

L1 and L2 filter chokes

A swinging choke is not necessary at L1 since this application uses a capacitor input filter. thus the output voltage has already soared to its maximum values. Also, the current load of this amplifier does not change appreciably - alleviating the reason for a swingin choke, even with a choke input filter. Critical inductance for a choke input filter is about 7Hy for this amp.

The specified chokes have more than adequate inductance and current capability and could serve in future mods. The 100ohm DCR is an important factor here due to low B+ overhead.

Why not regulation?

Voltage regulation was deemed unfeasible in this mod for several reasons:

1 The power transformer plate winding does not have adequate voltage output (headroom) for a series type regulator.
2 The plate winding does not have an adequate current capability for a shunt regulator.
3 Inadequate room on Ken's chassis.
4 Experience and test equipment availability. A first time layout on virtually any regulated power supply I have ever built has always oscillated. Other folks seem to have the same problem as several regulator kits and commercial "store bought" amplifiers I have checked also oscillate or go into a limit cycle mode. One popular solid state kit regulator has had a limit cycle oscillation at between 90mHz and 210 mHz on the three systems I have been asked to look at. The limit cycle mode,
manifested by a 1V to 10V RF signal riding on the B+ DC voltage, can only be dtected with the proper equipment such as a good fast scope. Cleaning up the limit cycle removed the hard edge on the amps involved. A popular all tube regulator making the rounds also hs a limit cycle pulse mode at several hundred kHz. The pulse train rides on parts of the 120Hz output. The 120Hz output of a volt or so was due to the extremely low bandwidth of the basic regulator circuit - DC to about 10Hz. It is hard for an error amplifier with a 10 Hz bandwidthto correct the 120Hz hum input to the V-reg.

To be truly effective, a regulator circuit must be faster than the load that is regulated. If your amp rolls off at 40kHz, a good rule of thumb dictates a 400 kHz bandwidth for the regulator - this is hard to do. Add a wideband noise requirement of less than 100 microvolts and a low dynamic impedance and the problem *really* gets hard. To get the gain/bandwidth for these two requirements is at the limit of the state of the art for solid state, virtually impossible with valves. This hard to do problem might explain the complaint of most folks that my power supplies are much too complicated - so they press on with their hum, hiss and turtle slow systems.

At any rate, getting back to test equipment, get yourself a surplus TEK 7704 or 7904 scope and at least a 7A26 vertical plug in (200MHz). 7904 mainframes are around $200 in this area. This setup will get you through 90% of the V-reg development problems. That 5 mHz scope might get through most audio amp problems but will not be fast enough for the power supply. Hopwever, that hard sounding 6922 preamp might also be oscillating at 400 mHz...

Grid stops

The majority of amplifier stage oscillations can be cured with a grid stop resistor. High G_m tubes (over 2000) love to oscillate and at some frequency virtually any layout will become a tuned plate, tuned grid (TPTG)oscillator, see a 50's ARRL Handbook. The simple expedient of placing a grid stopper at the grid lug of all tubes will usually stop the TPTG oscillation effect. When I say at the grid lug, I mean *at* the grid lug.

If you are of the screen grid valve persuassion, a grid stopper should be used on the screen grid lug, especially if the screen is returned directly to ground through a bypass cap. Also, do not take the shortcut of tying other leads to the grid lug. The only part soldered to the grid lug should be the grid stopper.

Plate stops (not used here)

On several recent occassions I have observed VHF/UHF RF oscillations between 200 and 400 MHz in commercial 6922 voltage amp stages. The layouts were ideal for an Rf oscillator, with relatively long (>1 in.) leads or traces to both the grid and the plate of the 6922, a really hot tube for RF work (for which it was designed).

The first amplifier was stabilized with a real stopper. The real grid stopper was kludged into the circuit trace next to the grid lug between the original film grid stopper (~1.5 inches away) and the tube. Remember, a lot of film and bulk foil resistors go inductive above 50-100 MHz. This circuit them became unconditionally stable over the audio cycle and sure sounded better.

The second amplifier calmed down with a grid stopper placed into the signal lead at the tube's grid lug. It did not oscillate continuously, however the circuit would break into a very low level RF oscillation during a portion of an audio signal - a most common problem, dude. this oscillation was killed with a 51 ohm 1/8 watt carbon comp resistor between the plate lug and the "non-inductive" plate resistor.

For starters, there is no such thing as a non-inductive resistor. At some frequency the so called non-inductive resistor will start showing a significant inductive reactance. If the tube and associated circuit has sufficient gain at that frequency it will oscillate, especially a high G_m frame grid tube. This greatly simplified explanation is meant to alert experimenters to the fact that many things are going on in even the most mundane circuit. Layout and parts selection are critical and every change should be evaluated. fortunately a critical ear can detect when a change makes the sound better or worse, but a new circuit may be discarded out of hand for a subtle reason that may only be betected with proper test equipment.

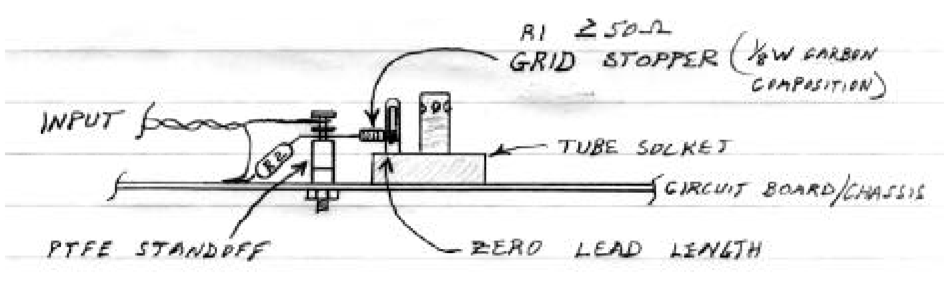
Note: the above part cycle oscillation only occured when the plate swing went over 10V p-p. the spurious oscillation was of a very low level , only 100 millivolts or so at the frequency of around 150 MHz. This appeared as a very slight thickening of the CRT trace during the most negative portion of the 10V p-p, 1 kHz plate swing. A high pass filter was kludged out of a 1 pF cap and a 10 microhenry RFC at the tip of the scope probe to better oberve the VHF oscillation, i.e. to get rid of the 1kHz signal. The oscillation would also be killed when the scope probe was connected to the affected stage. This phenomenon occurs frequntly, so the search for spurs can be conducted by holding the probe near, but not touching, various terminals. Of course the scope should be set to one of the more sensitive positions e.g. 5mV/div. with the X10 probe during spur searches. Never use a X1 probe due to bandwidth limitations.

The lessons here are that virtually any active circuit can amplify and oscillate at the same time, or oscillate at several frequencies, or any combination of the above. The famous hard sound of the 6922 is a typical example - it is usually oscillating. Also, suspect those very neat layouts where all parts are neatly aligned with leads or traces meandering all over the place. those nanohenries and femtofarads turn into nice VHF-UHF tank circuits.

Speedup resistor

Why the 82 ohm resistor in series with the diode across K2's coil? In the old days this resistor was called the speedup resistor - the physics of which I won't go into. As used here, this resistor speeds the release time of the associated relay. this reduces contact arcing to some extent and in this case to 1/4 cycle or so of the 60Hz supply due to pulsating DC nature of current flow.

I generally use a resistor value that approximates the DC resistance of the relay coil. This value halves the value of back EMF current flow upon shutdown, reducing the



relay armature magnetic hold force significantly. The down side is that the back EMF voltage spike generated is twice the relay coil voltage vs, approximately 0.7V. In this case approx. 16V. The 16V pulse is no problem for the PN2222A that is good for 60+ Volts. The 16V pulse might back into the 8V buss and damage the 555 but this pulse is clipped at ~ 12V by the 12V TVS. This is a side benefit of the TVS whose primary purpose is to clip line borne transients on the 8VDC buss. A tertiary purpose of the TVS is to clip the shutdown transient pulse from K1.

Easy Tweak

(editor's note: gasketing the bell ends as described below will void the warantee on MagneQuest products. We are not saying it won't work, just that you are risking dropping and stressing the unfastened core far worse than stresses described within this next section - proceed at your own risk)

Permalloy, mu metal and other high nickel (Ni) cores must not be stressed mechanically for optimum results. High tech cores are enclosed and floated in silicon grease or very compliant elastomers such as silicon rubber. The enclosure prevents winding stress to the core material after heat treatment thus maintaining the magnetic qualities of the core metal. The experimenter can relieve future stresses by proper mounting techniques. If the transformer is rigidly mounted to a chassis differential expansion rates will keep the core under a constant state of stress during operation. This tweak will prevent these stresses from building to typical levels. This tweak will also produce audible results on silicon steel cored transformers.

Mod Procedures

1 Remove the bell ends of the transformer. If the assembly bolts are steel, replace them with threaded brass rod.

2 Fabricate two rubber gaskets taht will fit between the bell ends and the core.I use the soft neoprene gasket material sold at hardware and auto parts stores.These rubber sheets are .020 to .030 inch thick and are dead soft and pliable. The idea is to prevent any machanical contact between the bell ends and the faces of the core material.

3 Cover the transformer assembly bolts/rods with shrink or vinyl tape over the portion that passes thorugh the core. Prevent mechanical contact between these bolts/rods and the core material.

4 Reassemble the transformer, ensuring that lead wires and gasket material are properly positioned. Tighten all nuts finger tight.

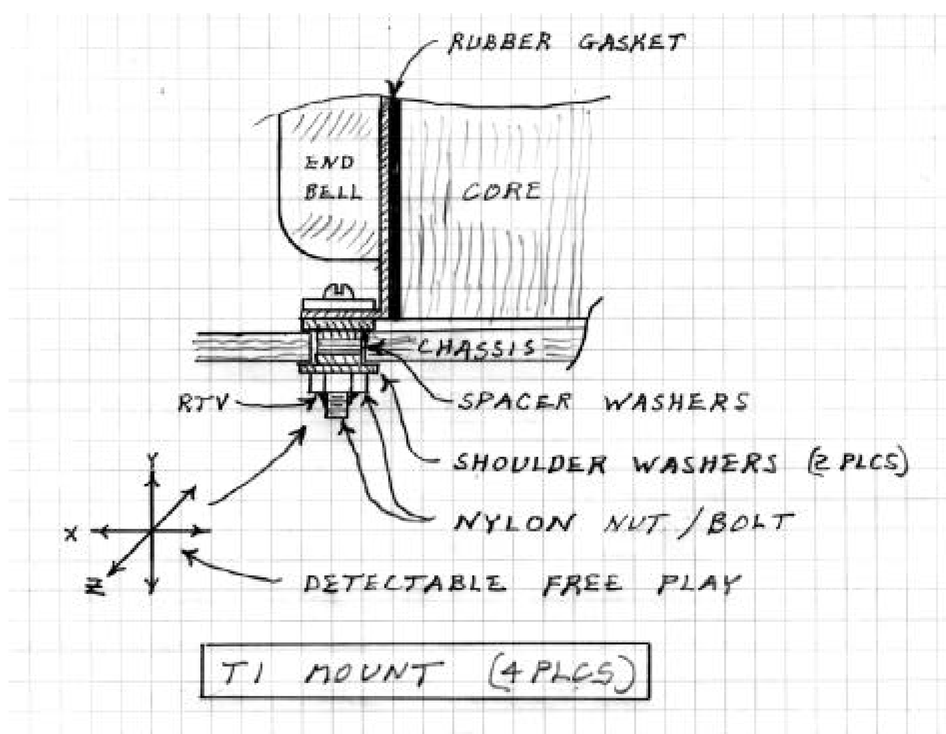
5 Draw all nuts down evenly using a nut driver. Draw down should be done in several stages using crisscross sequence like the auto wheel lug torquing method. Final torque should only be 6-8 inch pounds.

6 Degrease the transformer assembly and shoot with several coats of clear Krylon. This clear coat will stop the slight shock one will receive from the core or the bell ends during operation. The shcok is caused by the now totally isolated core rising to around B+voltyage due to electrostatic forces. Older paper insulated transformers should have a drain wire (small, stranded, tinned copper) inserted between the rubber gasket and the core. The drain wire should be returned to the amplifier chassis ground.

7 Mount the transformer using nylon hardware and shoulder washers. Drill mounting holes so that several thousandths of lateral play exists between washer shoulders and the chassis. Add plain washers as necessary between shoulder washers so that several thousandths of vertical play exists between each shoulder washer set and the chassis. The transformer should be free to move several thousandths both vertically and laterally afetr all nut/bolt sets have been torqued to 8-10 inch pounds (8-32 hardware). After final assembly and debug, the nut/bolt sets may be RTV'd for long term security.

On MOVs

I have been using MOVs on every piece of gear built or overhauled since 1975 when my house in Tampa received part of a lightning strike to a nearby pine tree. Most of the stroke went directly to ground through the tree as evidenced by the complete debarking of the 10 insh caliber tree. Part of the stroke went over to the house through several dozen roofing nails and thence into the house wiring. My brand new (1 month) solid state Heathkit TV and every piece of ham gear using FETs were damaged. Also every motor in the house including the AC compressor plus water heater and stove heating elements were zapped.



While at Graingers buying new compressors for the AC and refrigerator, plus all those other motors, a prominent display of GE Thyrite surge suppressors caught my eye, so I bought several. In addition GE MOVs were starting to appear in electronic parts houses, so I got a hand full of those. I placed a Thyrite across the electrical service entrance, across the breaker panel, the Ac compresor and the AC airhandler. 20 joule MOVs were placed across all other motors, all appliances, and all electronic equipment.
A year later alomost to the day my ham antenna mast took a direct hit - a portion of which got into the houe wiring and vaporized the innards of the power meter. Also had a lightning ball bounce between the AC grills in the living room, so plenty of energy entered the house. The only damage suffered during this second hit was to the masthead preamp where the helicoil front end filter was vaporized along with that new $40 FET.

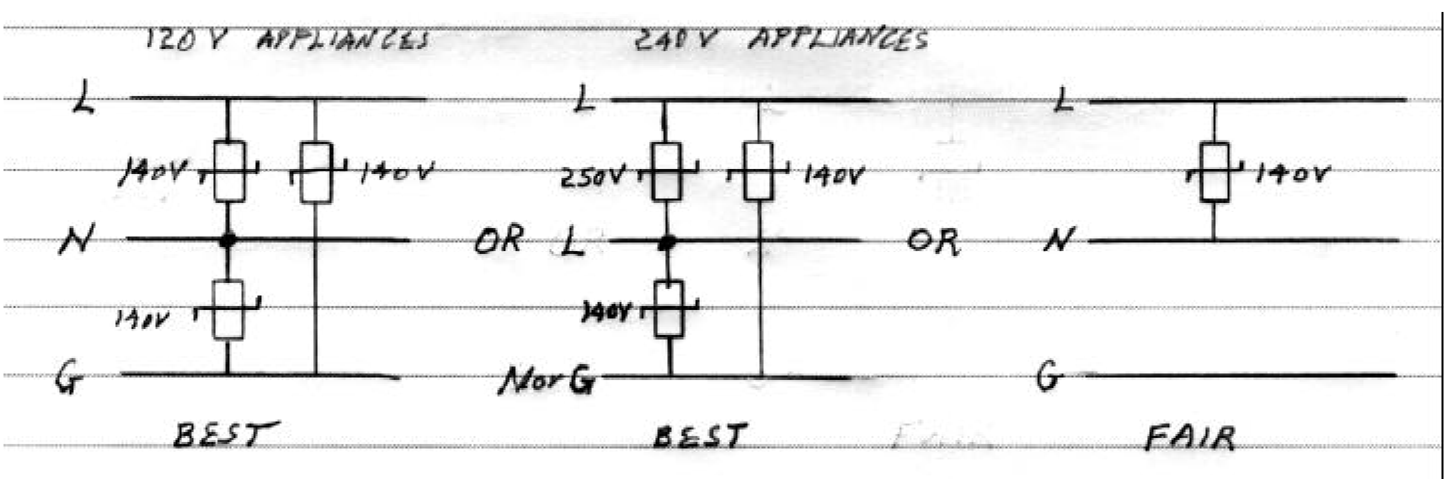
Since that time I've treated each new house the same way, thyrites and MOVs across everything. Four or five years ago the present house took a hit ot the chimney mounted TV-FM antenna. the only damage suffered was the vaporized balun between the antenna and the masthead amp. A coax spark gap suppressor even saved that super lo noise transistor in the front end of the mast head amp. I have yet to experience any of the ills suffered by several writers in recent audio rag articles. Even if i did suffer a MOV failure or two I would really be happy. That six bit sacrificial lamb went down fighting and savd me a thousand bucks of bitching and moaning while fixing damage.

The gradual degradation of MOV devices has also not been noticed. Maybe this is due to the dual layers of protection offered by the Thyrites and several dozen MOVs across the line at any one time. Initially I used to measure the breakover voltage on MOVs installed in test equipment undergoing calibration. No observable increase in breakover had occured in many samples so I quit the practice 5 or 6 years ago. I still check the MOVs across the fridge occasionally and no deterioration has been noted. This compressor motor produced up to 6 kV pulses on each shutdown.These spikes are reduced to about 1kV with the MOV protection.

GE Thryrites are code in the US and Canada and are available at the nearest GE supply. They are called "Traquell surge arrestor" with pn 9215ECB001 at $60 - 70 each. These deviced are easy to install in a convenient knock out or can be suspended by the elads in breaker boxes, etc. Keep leads short and straight, one black lead to each side of the 220VAC line and the white lead to the neutral block.

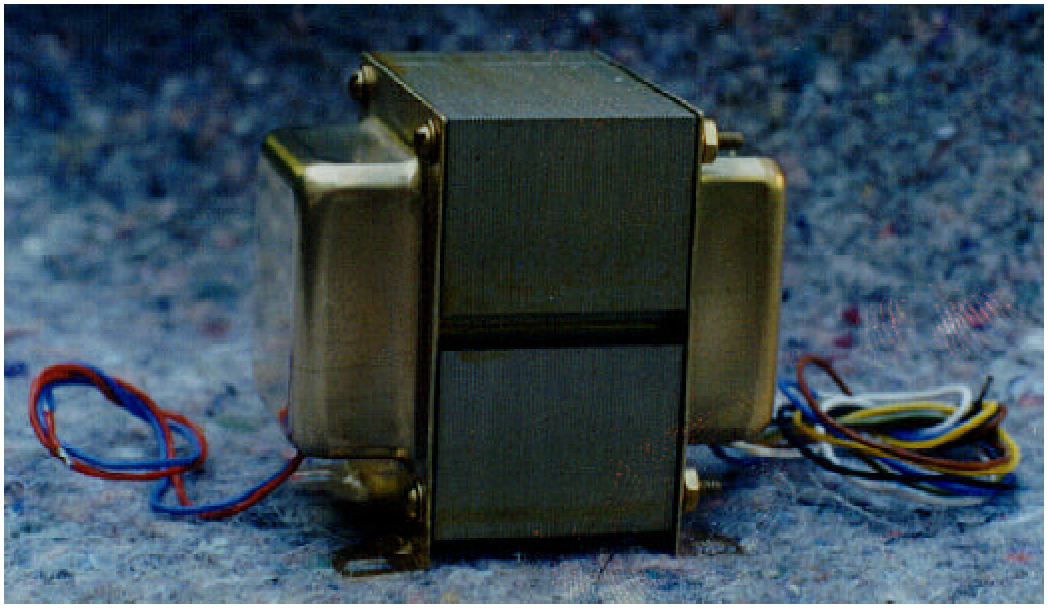
MOVs should be connected across the line and from both line and neutral to ground in major appliances and other high dollar equipment. For the small stuff, place one across the line, line to neutral.

On inaccessable gear such as the fridge and microwave place the 3 MOVs across the back of the wall receptacle.




3 Watts...106dB....
Can't get much more efficient than that!
Lowther America and Welborne Labs have teamed up to offer the best package deal in Audio.
Hi-Fi enthusiast or just plain music lover take a look at this........
A combo package featuring Welborne Labs Moondog 2A3 SE monoblock amplifiers along with Lowther America's Medallion II cabinets and Lowther PM2A drivers.
And... the best part is..... the price!
Full Kit only... $2949.00
Completely Assembled... $3999.00
For more information on this package deal contact either party
Welborne Labs
P.O. Box 260198, Littleton, CO 80126 USA
tel: 303.470.6585 fax: 303.791.5783
http://www.welbornelabs.com
Lowther-America
P.O. Box 4758, Salem, OR 97302 USA
tel: 503.370.9115 fax: 503.365.7327

THE EXO-50



WHAT THIS COUNTRY NEEDS IS A GOOD 5 WATT 845 AMP

MIKE LAFEVRE, MAGNEQUEST

Here's a neat design idea Paul Joppa whipped up in an evening, after an e-mail from Doc. The basic premise was to do an 845 amp using the PGP 8.1 power trans, and the EXO-50 parafeed output transformer. Here's what Paul came up with -

"With a full wave bridge and a choke input filter you can get 630VDC minus the choke losses, at 60 mA. This is workable, a 5800 ohm load is optimal so the 5K EXO-50 should work well. I recommend leaving the PGP 8.1 CT alone. The filter choke needs to be pretty big, at least 15H, to get proper performance at full current, and at that inductance it needs to be rated for the full AC also, probably 100mA or more. The caps need to be rated for 1kV peak, of course (660 VAC).
If you do it as cathode bias (69VDC) you drop to about 525VDC across the 845. The operating point is very good - it only dissipates 32W (those $40 a piece Chinese 845s will last forever! - B.) and you'll get 7.5W output.
Pushing driver plate voltage down to 200VDC and running it at 4 mA, you will get into 10K Rp territory, 12AT7 types could work."

Doc drew up a rough and ready schematic, which is shown on the next couple of pages.

This is an untried circuit, but as usual we have a pretty high confidence level in it's performance. What we would like to do is invite your questions and commentary on the Bottlehead Forum of Audio Asylum. We will use the Forum to offer up refinements on parts values and info on things like the availability of that unamed MagneQuest filter choke...

EXO-50 parallel feed output transformer -
5K primary, 16,8,4, ohm secondary, 20 watts, M6 and Permalloy "Pinstripe", $550 the pair

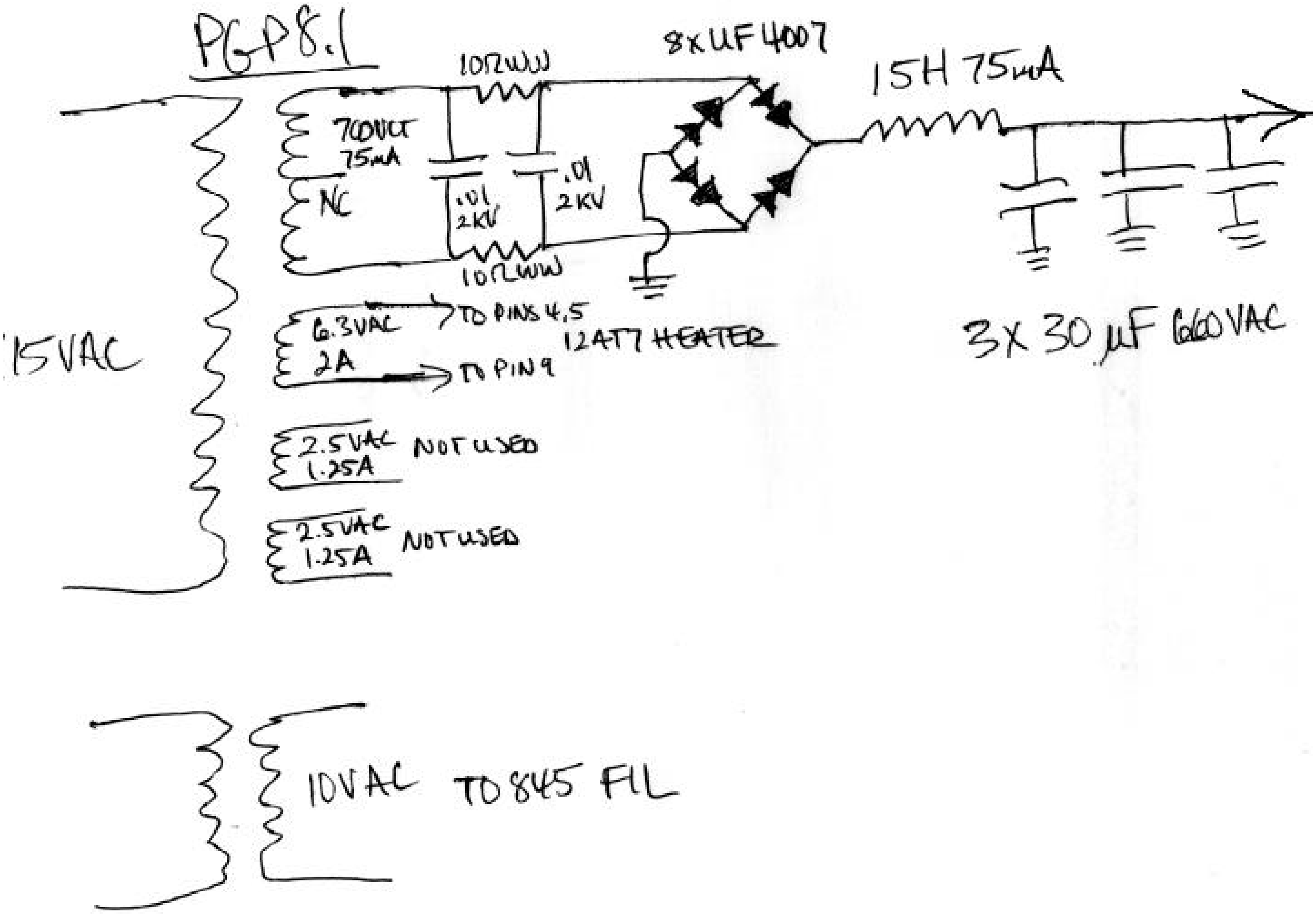
EXO-04 plate loading choke -
50H, 60 mA, 317 ohms DCR, $198 the pair

BCP-16GC grid choke-
!!!!!H, no DC, $80 the pair

PGP 8.1 power transformer -
$165 the pair

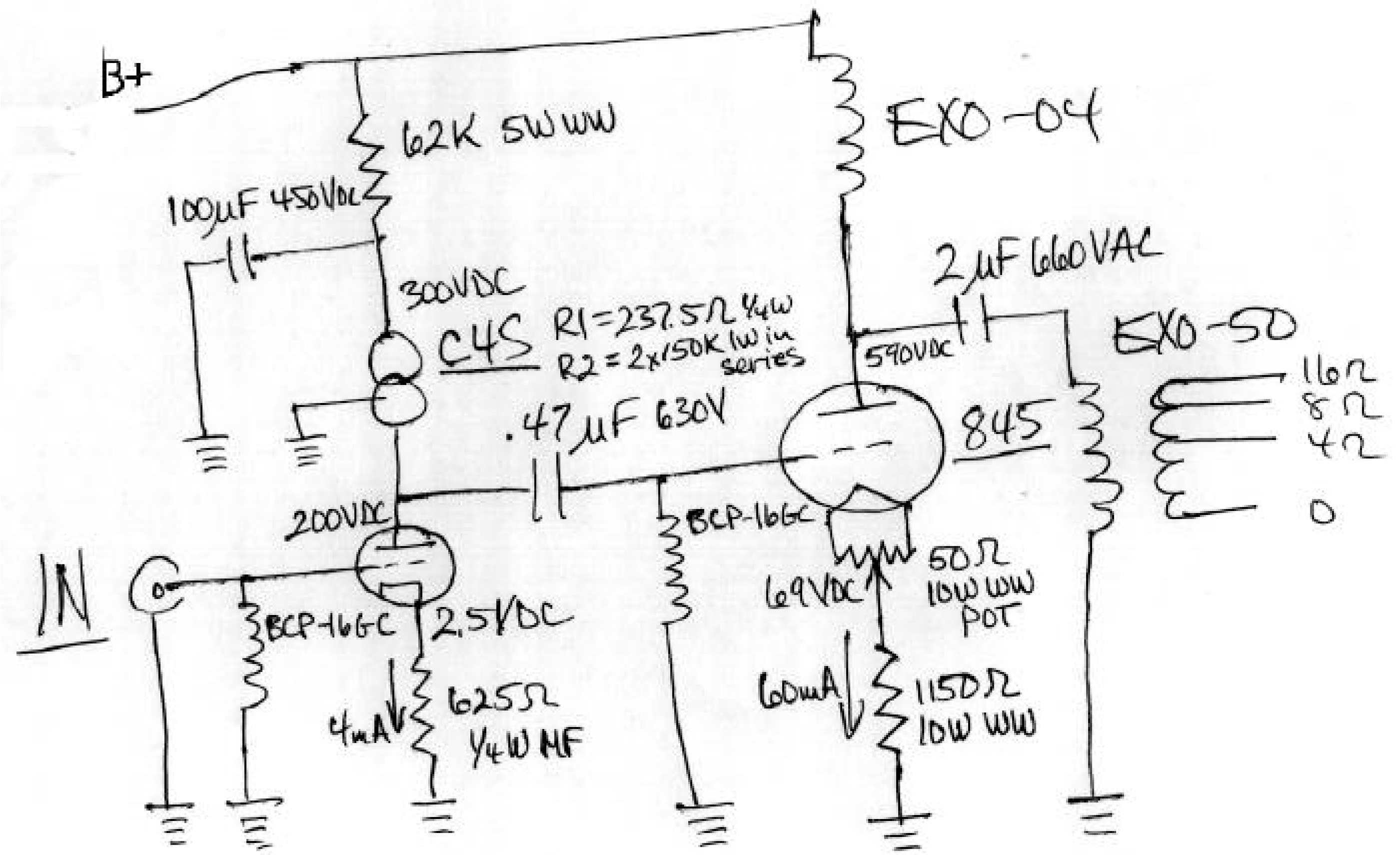
C4S active load kits -
$35 the pair

LARGE RICHARD
A PARAFEED 845 SE AMP
POWER SUPPLYSCHEMATIC



10VAC filament transformer could be Mouser PN 553-VPP105600 (Magnetek10VAC 5.6A)
Filter caps could be Mouser PN 5987-660V30 30 mF 660VAC C-D motor start cap
15H 75mA choke from MagneQuest TBA
Use double UF4007 to handle voltage peak
See Buddha article in this issue for info on reverse recovery spike filter ahead of full wave bridge

LARGE RICHARD
A PARAFEED 845 SE AMP
AMPLIFIER SCHEMATIC



Try Mouser PN 5987-660V2.0 C-D motor run cap for parafeed coupling cap, or other 2-3 mfd 1kVDC rated cap.
MagneQuest BCP-14 with 100Kohm 5W wirewound resistor may be substitued for C4S load and 62K WW resistor. Don't leave out the 100mfd cap!
50 ohm 10Watt pot may be available from All Electronics, www.allcorp.com, PN POT-50C
Use your favorite flavor of wirewound resistors. Ohmites are very alright in Doc's book.

da basics

Basic design considerations for plate loaded triode stages

Here's an very cool reparte that occurred between Bart Shepard and Paul Joppa, after Bart requested some enlightenment on the Sound Practices "Joelist". Note here that Bart is very humble in his asking for help, but that he has obviously studied hard to figure which questions to ask - he's not just throwing cookbook circuits together, but rather he's working to grasp the knowledge tht will let him design his own fantasies - dass' what I'm talkin' about!!! - B.

Hi guys,

I have a couple of really basic design questions that keep bugging me and thought I'd ask them here to see if any of the very knowledgeable guys on the list could sort me out.

I am interested in the design of a basic plate loaded triode stage. As I understand it a constant current through the tube will provide for minimum distortion and maximum gain. Hence all the fancy totem poles and CC sinks and sources around.

— yes; though power supply isolation is another benefit.

I also understand that these effectively provide a very high impedance load.

— yes

My first question is what limits just using a very large plate load resistor? The usual limitation quoted is the high B+ voltage required to provide the desired plate voltage. But in , for example, a 211 or 845 power amp, high B+ is not a problem.

— depends on how high an impedance you want. Just looking at the plate curves and thinking of distortion, a load impedance of 2-3 times the tube's Eb/Ib gets you most of the way. But for power supply isolation, that only buys you 10dB or so. Very high load impedances can be achieved - I think the CCCS is at least 10 megohms - that gives some 60dB isolation. That's why John Camille pushes for those high impedances. I know several people who claim to hear the difference; my own direct experience is not enough to make any claims.

Does the noise of the load R become a problem? If so, in what circumstances? Is this just an issue for pre-amp stages? Surely not for high voltage swing driver stages.

— yes, it does. Most bulk resistor materials (carbon, sputtered metal) exhibit some noise voltage proportional to the voltage across the resistor, in addition to the thermal noise common to all resistors. The higher the voltage, the higher the noise; consequently it cannot be ignored in driver circuits. Solid metal resistors (wirewound, bulk foil) show much less of this behavior. That's why Mills wirewound are typically called for as plate loads. Also the voltage capability of the resistor is a limit. Most resistors are rated for 200v or so. So a "good" plate load might require several resistors in series, if operating from a 1000v power supply.

The next limitation I am aware of is the resulting high Zout for the stage. This leads to my next question.

— the output impedance is the plate resistance in parallel with the load resistance; it doesn't go up more than 30% or so relative to a conventional resistor-loaded circuit. Often the CS loads are used with an unbypassed cathode resistor, however, which raises the effective plate resistance by (nearly) mu. That can be a problem.

How do I calculate the maximum Zout allowable to correctly drive the output load (e.g. should Zout be < 10% following stage Zin??) and in fact how do I calculate what this load is when it is the grid of a following stage?

— Usually the most important factor is the grid capacitance. There are two limitations, frequency response and current capability. Frequency response is the driver source resistance (see above) interacting with the capacitance. Most designers seem to think that a -3dB frequency of 100kHz or more is desirable. For current capability, I think it was jc morrison who said that the standing current in the driver stage should be 5 times the rms current drawn by the capacitance at 20kHz. Both of the above criteria seem to be quite conservative.

If I design to not have to drive the following stage to extremes I should be able to avoid grid current, shouldn't I? So shouldn't this load be not much lower than the grid resistor for a self biased stage?

— Only very few tubes have a max. grid resistor so low as to be important here. The type 50 is an example; it specifies a maximum 10k grid resistor as I recall.

Do I need to take into account Miller effect as an additional load? If so, how? (add Cgp & Cgc then times gain??) Should this reactance be > 10 times the load on the grid?? or does plate load only affect this re frequencyresponse?

— Certainly; see above; it's the dominant load usually. Strictly it's Cgp times gain, plus Cgk, plus stray capacitance depending on layout. It's usually good enough to use Cgp times mu.

Does the nature of the following stage matter? It seems that output stages running high currents need better drive than low current VA stages. Why?

— Basically, output tubes are physically large and have highter capacitances. Plus they need lots of drive voltage, which increases the current into their capacitance, thus increasing the minimum standing current in the driver.

Is this due to a need to be able to supply drive current? If so, why, if not driving into grid current or does grid current start at biases well above zero volts??

— as noted above, it's the drive current into the grid capacitance. There probably is some advantage to being able to drive into class A2 on transient peaks, but that's a whole different can of worms. (Incidentally, *some* grid current shows up when the grid is within 2V of the cathode, depending on details of the materials...)

Or is it due to a need provide a low impedance load on the grid for some rea-

son????

— no

Is a low driver Zout only required for its ability to deliver drive current or are there other reasons?

— As above, the frequency response is another consideration.

What appear to be trivial basic questions soon seem to get pretty involved to me and I haven't found the real answers easy to come by in any of the introductory texts I have looked it. A lot of this stuff seems to be skimmed over, an infinite grid impedance not requiring any current!!

— yes.

Sorry if this stuff is real basic but perhaps there are others like me who get OK results but don't really deeply understand the issues and your responses may help them also.

Cheers,

Bart (not too proud to ask :-))

interconnect cable kits from Electronic Tonalities
pre-cut twisted pair 20.5 guage High purity continuous cast long crystal solid copper conductors with a high temperature insulative coating, pre-cut polyethylene outer jacket and Vampire Wire RCA plugs
$39 .5 per meter pair, $49 per 1 meter pair, $59 per 2 meter pair